Electronic Still Camera/dscam Cookbook and Checklist

Pre-survey, for both science and Jason personnel.

Jason *data processor, assist the chief scientist or science watch leader in specifying her/his survey with the materials found in this document.*

⇓Our gratitude to Dr. Chuck Fisher and team at the Penn St, who shared the content in the gray sections.

Mosaicking on the seafloor: general guidelines

- *Choose an area to mosaic*
    - i. Select relatively flat terrain - substantial changes in topography will result in highly distorted mosaics
    - ii. Once you identify a suitable area to mosaic, deploy at least 1, preferably at least 3-4 markers (depending on the size of the area you choose to mosaic). Markers will provide a way for you to relocate the exact location of your mosaic in the future - underwater navigation is good, but not perfect. Markers can also be used as a size reference in images.
- *Choose and maintain a constant altitude above the seafloor*
- *Choose and maintain a constant heading*
    - i. The submersible will have to move forwards and then backwards in overlapping, parallel lines, otherwise you will have pictures that are oriented in 2 different directions
- *Maintain a constant speed*
    - i. Before beginning a mosaic do a few practice runs and determine a speed that provides sufficient overlap. The strobes take at least 5 seconds to recharge and you will need to keep this in mind when finding a speed that allows you to get overlapping pictures as well as pictures with adequate illumination.
- *Get LOTS of overlap*
    - i. Too much is better than too little. You can't do anything with images that are not overlapping. Aim for at least 30 percent and even as high as 50% overlap in your images.
- *Turn on the lasers*
    - i. Lasers help calculate the percent cover of different substrates or fauna and it is useful to have a size reference in a majority of the images
- *Do your best to make each run/transect in a straight line and the same length – this will greatly aid your image processing later on*

**If you plan on doing a lot of mosaicking or imagery collection during a cruise, I would suggest dedicating part of one dive to trying different camera settings before collecting images to keep for mosiacking- if you are using the Nikon Coolpix (by far the best option in terms of resolution), you will not be able to see the images until they are physically downloaded from the camera once JASON is on deck. Test different altitudes, different lighting combinations, different submersible speeds, and different camera settings (f-stop, etc) etc. in order to ensure you obtain the highest quality images possible.

Choosing a camera

There are three still image cameras carried by *Jason*, each of which can potentially be used in a photo survey. This checklist focuses on the Prosilica electronic still camera in conjunction with the 'dscam' software program. These provide a downlooking configuration with software control, and were assembled to be *Jason's* photosurvey package. Other choices are the Insite Scorpio digital still camera, which offers pictures of higher spatial resolution (2048 x 1536) and smaller resolution (8 bits/pixel) in color intensity than the Prosilica, with software control not suited to a survey. Stills from the high definition science camera may also be used. Its packaging makes it more suitable for a forward-looking (vertical wall) survey. Neither of these cameras has a fixed chip size to lens size ratio, field of view can be varied by the user, and therefore no parameters are offered in this document. Changing field of view will negatively affect efforts to join adjacent images.

Survey design parameters

In the case in which the survey is ad hoc *rather than designed, the watch leader should be made aware of camera footprint constraints.*

1. Camera unit is a Prosilica/GE 1380C, 1360x1024 spatial resolution, 12 bits/pixel digitization.

    i. 2/3 inch chip, 9mm lens:

    ii. vertical view angle= 30°: *determines forward speed of Jason*

    iii. horizontal field of view = 38°: *determines trackline spacing*

    iv. Footprint for Prosilica GE 1380C is

        1. Front to back (vertical): 0.54 * distance

        2. Side to side (horizontal): 0.69 * distance

    v. Other cameras can be characterized using *http://www.deepsea.com/lensfield.php*

2. Nominal strobe charge time is ten seconds. However, it may be less. Check with the *Jason* expedition leader.

    For contiguous coverage, ROVspeed <= vertical footprint/one charge time. Overlap is Good.

3. Overlap is determined by science's intentions.

    If mosaicing is intended, see the guidelines from Fisher/PSU above..

4. Survey altitude should be determined experimentally at its beginning, and will vary depending on available light, turbidity, and scientific requirements. See footprint numbers in the table below. Set vehicle speed for adequate overlap.

5. Record vertical and horizontal spacing between position of altimeter and camera ______

- *Camera is usually on the bow in the basket while the altimeter and DVL are on the aft end, ~9 feet (2.74 m) spacing. Over rough terrain the altimeter may see a different height than the camera. Also, pitch (nominally 10° forward) over 9 feet means the aft end is about 1.5 feet (0.45m) higher than the camera.*

- *Vertical spacing with* Jason *flat: altimeter is ~4 in (10 cm) higher than basket, the DVL is ~24 in (60 cm) higher than basket.*

  So, if the camera is if mounted in the basket its altitude is about 0.5m less than an altiimeter measurement. Let science know. Currently, altitude reported in .ppi files gives the altimeter measurement.

Table 1: Field of View and Corresponding Vehicle Forward Speed, No Overlap.

Altitude (m)	Front to Back Field-of-View (m)	Side to Side Field-of-View (m)	Vehicle Forward Speed, Max (m/s)	Time for 500m trackline (mins)
3	1.6	2.1	0.15	56
4	2.1	2.8	0.2	42
5	2.7	3.5	0.25	33
6	3.2	4.2	0.3	28
7	3.75	4.9	0.35	21

Science watch leader has (experimentally) determined altitude by reviewing camera output ______

Science watch leader has determined rate of forward travel for vehicle ______

Altitude and forward travel rate are required by the pilot.

Science watch leader has determined trackline spacing. ______

Trackline spacing is required by the navigator

Survey design completed ______

Science event logger in place ______

Survey preparation complete ☐

DiveID ____________ Date________________ _________ Data Proc ________

Pre-dive hardware setup, for use by Jason *personnel.*

Prosilica camera is in bottle, mounted to ROV, connected electrically, and networked. ______

dscam host (IBM T61 running WindowsXP), networked. ______

If needed, a spare host was set up. Lenovo G560 (also spare for DSC and EventLogger/HD GUI)

Disk space is adequate for planned survey. ______

For any surveys over ~ 1 hour: an external hard drive as dscam output. ______

dscam capture rate for 1:10 seconds is ~5GB/hr. Network transfers are too slow for larger volumes.

dscam host is time synced to the control van's NTP server (198.17.154.208) ______

Picture destination top directory created on dscam host ______

(*e:\dscamPics\<cruiseid>\<diveID>\<surveyID>*)

c:\dscam.ini edited to define 10 or more destination subdirectories ______

Every restart of dscam advances the outdirectory definition down the list you created in dscam.ini. It's possible to quickly use up the list, perhaps during deck tests. If that happens, dscam will crash/segfault on subsequent restarts.

c:\dscam.ini edited to define the image count at which a new folder is created to be appropriate for archive media ______

If storage is DVD, then new folders at 400 images. If hard drive, then 1000 or even 2000 images.

Camera is powered and responds to pings from dscam host ______

Manual triggering yields captured image in dscam display. ______

Troubleshooting hint: if images aren't coming back it may be that the camera was power cycled while dscam was running. Stop and start dscam.

Test images stored in destination subdirectory. ______

Pre-dive steps completed ☐

In-survey

The primary user of the dscam computer is responsible for monitoring disk space usage. Logging of events using the VirtualVan event logger, e.g., "start time", "position of line", is the responsibility of the on-watch science data logger.

Post-survey

dscam program terminated _______

Image files from dive transferred to data processor station _______

The method of file transfer is at the data processor's discretion.

Some possibilities: sftp using filezilla; folder sharing using Windows; USB drive.

If using Windows Sharing, output top directory must be shared to 'J2group'

Photo position file (.ppf) generated from dive navigation *(if time allows)* _______

PPIs/PPFs are a nascent data product, and you should describe them in that section of the post-cruise data package summary.

Generate .ppi file in matlab.

Use *photoinfo.py* to combine .ppi and photos list into a .ppf

Image files from dives archived to science and NDSF data packages _______

Survey checklist complete ☐

Image post-processing

Again, from Dr. Fisher's group…

1. **Processing Images**
    - Open images in Photoshop
    - Auto-adjust (Image>Adjustments):
        - i. Levels (Shift + Apple + L)
        - ii. Color (Shift + Apple + B)
        - iii. Contrast (Shift + Apple + Option + L)
    - Batch processing images makes this go a lot faster. (In Photoshop: File>Automate>Batch), however, if there are any issues with inconsistent lighting it may be necessary to adjust the images manually with other controls, such as Photoshop's brighten, manual levels and contrast tools, and shadow/highlight tools.
    -
2. **MatLab requirements and .seq files**
    - *MatLab will not read any file names with spaces* (must use an underscore instead), therefore when mosaicking, it is best to create a photo mosaic folder as a direct subfolder in the C drive.
    - Create as many subfolders within the photo mosaic folder as you want; however, you will have to place the particular folder with the images you want to mosaic and corresponding .seq file directly under the photo mosaic folder.
    - MatLab reads .seq files to know which images are being mosaicked together and in what order
        - i. The easiest way to create these files is to take an already existing .seq file, rename and resave it with the file names of the specific images you would like to mosaic
        - ii. When creating the .seq file, make sure the file names you put in the file are the exact file names of the images, otherwise MatLab will not be able to process the images
        - iii. All filenames referred to in a .seq file must be the same length (i.e. same number of characters).
    - On the same level as the .seq file (directly under the photo mosaic folder) you must create a folder that has the exact same name as the .seq file
        - i. Within this folder place the images you want mosaicked together
            1. It's ok to have images that aren't referenced in the .seq file in the folder- they just won't end up in the mosaic
        - ii. Images must have the same dimensions in order for mosaicking to work
            1. This isn't a problem for images downloaded right from the submersible since they are all the same size
            2. However, when you are stitching together lines of already mosaicked pictures, you will have to crop the lines to the same dimensions – this can cause problems if you don't have a lot of overlap because will lose a lot of data while cropping images to same sizes. Keep this in mind when first mosaicking raw images. Try and make each line contain the same amount of images (ex: 8 images in each segment, MatLab usually won't mosaic more together at once than that, but this all depends on your computer's available memory and processor speed)
            3. Also, when a segment is completed, MatLab will generate a black border in all the regions that did not overlap in the photos. Therefore, you will first have to crop the segments in PhotoShop to eliminate all black. If the mosaic wasn't taken in a straight line, you are going to lose a lot more data when cropping the black and then even more when cropping to appropriate

data when cropping the black and then even more when cropping to appropriate dimensions

2. Mosaicking with MatLab

- Open MatLab from the desktop
- Type mosaic_GUI and press enter
- Mosaic Controls will open
  i. Click “Select and Match Features”
  ii. Subsample to ½ resolution (if you don’t want to do this, replace the yes with no)
  iii. Open folder which has .seq file and corresponding image folder within
  iv. Open .seq file
  v. Program will start running
- Pickpoints (if you have enough overlap, you won’t have to worry about this)
  i. MatLab will stop running because it can’t find sufficient overlap between pairs of images
  ii. Type “pick_points3”
  iii. Choose 5 control points in the left image that you can also identify in the right image. Then choose the corresponding points in the right image – when choosing control points try to get a variety of locations and choose points to minimize distortion in the final mosaic.
  iv. Type: “ff – gg” press return
  v. Type: “links(fi,gi) = 1” press return
  vi. Type: “return” press return
  vii. MatLab should continue to run
- Make Mosaic
  i. Once MatLab has aligned the pictures, the program will stop running (monitor progress in bottom left corner. If it says “busy” don’t push anything)
  ii. On the mosaic control pad choose “Make Mosaic”
  iii. MatLab will then begin blending the aligned pictures together
- Once you have a final image, it will be displayed on the screen and be automatically saved (along with all processed images) to your folder with the raw images

‘mosaic_gui’ is a matlab toolbox written by Dr. Oscar Pizarro and others when Dr. Pizarro was a postdoc with Dr. Hanumet Singh/WHOI Deep Submergence Lab circa 2003. It is available to NDSF clients for their mosaicking projects. However, it is not under active maintenance or development by NDSF.

Documentation

Pizarro, O., Singh, H. “Towards Large Area Mosaicing for Underwater Scientific Applications ”, *IEEE Journal of Oceanic Engineering, Special Issue on Underwater Image and Video Processing*, pp. 651-672, vol 28, no 4, 2003.

Pizarro, O., Eustice, R., Singh, H., “Large Area 3D Reconstructions from Underwater Surveys ”, accepted for the *IEEE 2004 Oceans Conference*.