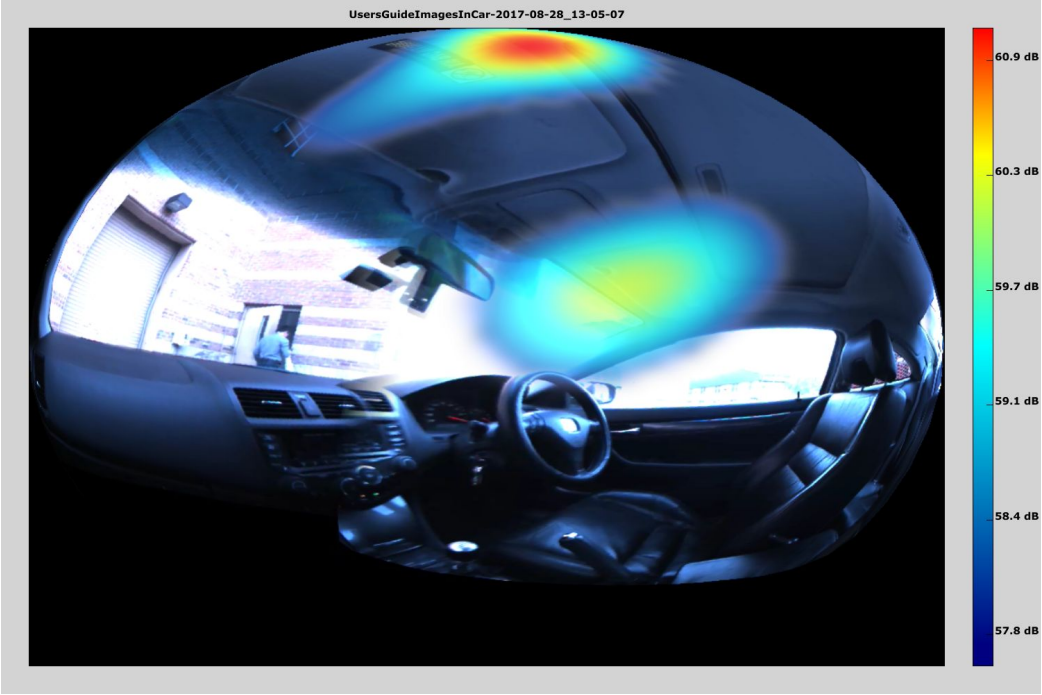
VisiSonics 5/64 Audio/Visual Camera

User Guide

Version 2.3 - March 2019



This document provides instructions on the use of the VisiSonics 5/64 Audio-Visual Panoramic Camera and associated software. License terms are also provided.

The VisiSonics 5/64 Audio-Visual Panoramic Camera uses software and technology from the University of Maryland, used under license.

Table of Contents

1. List of Components Supplied

- ❖ VisiSonics 5/64 Audio/Visual Camera
- ❖ Acquisition Computer with a Powerful GPU
- ❖ Table Top Tripod
- ❖ USB 3.0-B to USB 3.0-A Cable (black)
- ❖ Laptop Power Supply (large)
- ❖ Audio/Visual Camera Power Supply (small)
- ❖ Pelican Carrying Case

2. Notices and Warning

This device and software are supplied under license given at the end of this document. Use of the device is subject to agreement with the terms of this license. The VisiSonics 5/64 Audio/Visual camera is a delicate electronic device. It should not be shaken, dropped, or subject to stress, jerky motion, or extreme temperatures. The device storage and operating temperature is from 5 to 40 degrees Celsius. Always use the included Pelican case to store and transport the Audio Camera. Failure to handle with care or to properly store the device voids all warranties. The device contains no user serviceable components. Opening the device immediately voids all warranties. Should the device fail to function under normal operational conditions, VisiSonics will cover repair at its cost (less shipping) during the first year after purchase, subject to the condition that the device has been properly maintained. Repairs will be covered in subsequent years only if an appropriate service agreement is in place. Otherwise, repairs are billable for both time and materials; contact VisiSonics for further details.
Warranties cover the physical camera only; they do not extend to the laptop, tripod, and cables. Some of these items are covered by their respective manufacturers' warranties.

3. Camera Overview

The VisiSonics 5/64 Audio/Visual Camera ("Audio Camera") consists of five (5) USB 3.0 cameras and sixty-four (64) omnidirectional electret microphones arranged in a specific pattern on the surface of an aluminum sphere (8'' or 20 cm in diameter). The Audio Camera interfaces with a laptop computer provided by and certified by VisiSonics. The laptop comes with the FINDr software installed. The unit and all accessories are shipped in a waterproof, foam-filled wheeled case. The case is equipped with four latches that must be securely fastened for transportation. The laptop, tripod, cables and Audio Camera are all located in cavities in the foam. The cables include the USB 3.0 cable and power supplies for both the Audio Camera and the laptop.

3.1. Physical camera setup

- With Included Tripod
    - Carefully take out the laptop from its slot and place it in a secure location
    - Extract the tripod from its slot
    - Extract the camera from its slot and affix to the tripod
    - Place the camera/tripod stably on a flat surface, taking care to ensure that the suction cup is adhered firmly to the surface below

- With Optional Audio Camera Mount

- Remove quick release plate from swivel head on the Audio Camera mount
- Attach the quick release plate to the bottom of the Audio Camera, ensuring the the quick release plate is squarely aligned with the base of the Camera
- Insert the quick release plate into the swivel head
- While supporting the Audio Camera, release tension on the swivel head ball joint, position the Camera straight up and down and retighten the mount
- Place Audio Camera mount against a secure surface in the desired structure or vehicle. In automobiles, this is typically the passenger seat or on top of the center console
- Use the four straps at the corners to secure the mount in place by stretching them underneath the car seat (or other location) and then tighten them up by ratcheting the orange levers until the mount feels secure
- Readjust the Audio Camera position to compensate for any tilt caused by the mounting position

3.2. Cable connections

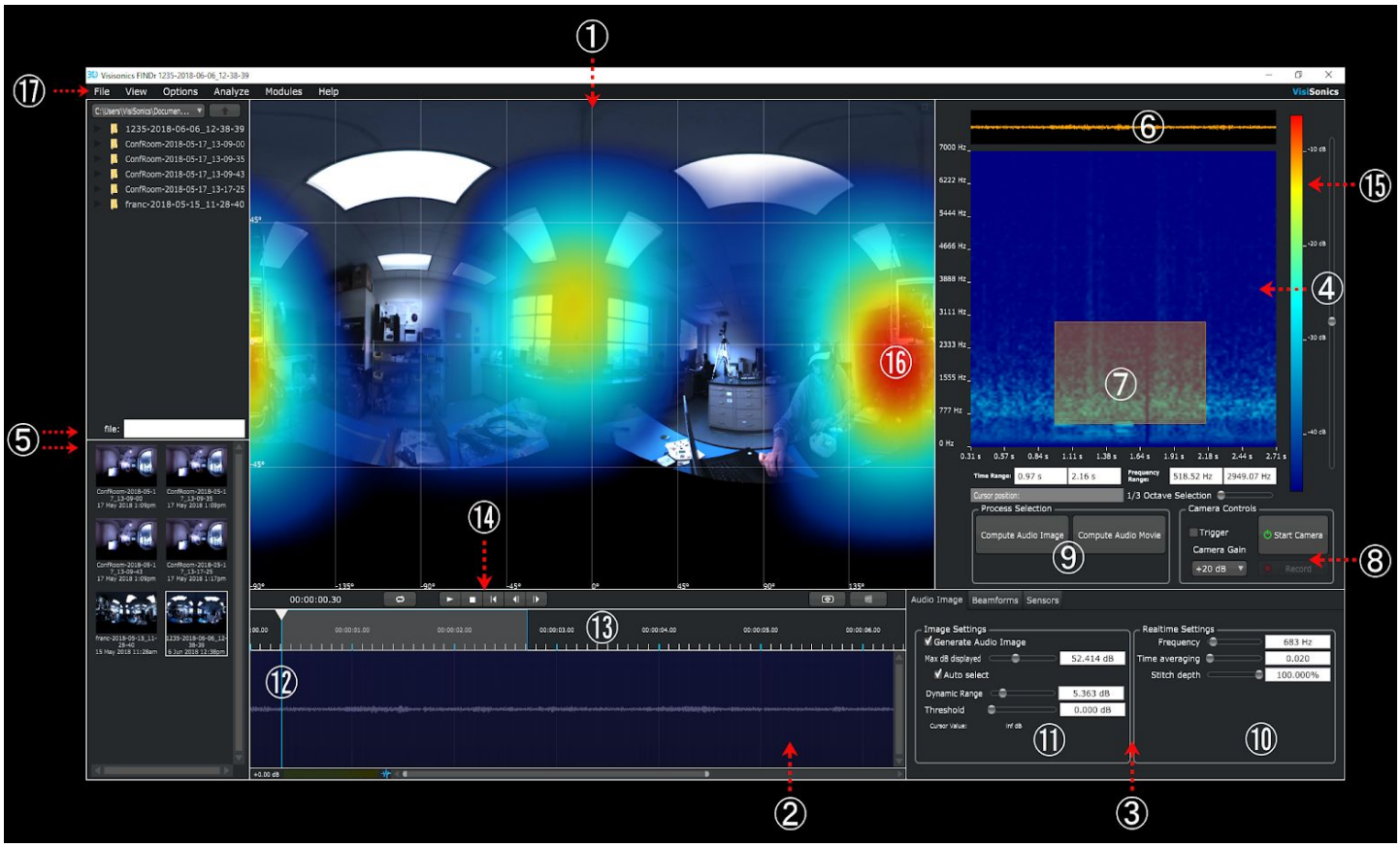
- Boot the computer. [Username: VisiSonics Password: changeme]
- Plug in computer power supply for optimum performance
- Plug the USB 3.0 -A jack into the laptop
- Plug the USB 3.0 -B jack into the appropriate port in the Audio Camera handle
- Plug the Audio Camera labeled power supply into the Audio Camera handle

Warning: Switching the Audio Camera power supply and computer power supply can damage the devices. The Audio Camera power supply is 12V, 3-4A.

4. Audio Camera Software Guide

Navigate to C:\VisiSonics and run FINDr.exe (a shortcut can be found on the desktop). This window shows all the functionality of the Audio Camera. Each button and its use will be explained in detail in the following sections.

4.1 General Overview



Quick Reference:
① Video Window (4.2.1)
② Timeline Window (4.2.2)
③ Control Panel (4.2.3)
④ Spectrogram Window (4.2.4)
⑤ Session Browser (4.2.5)
⑥ Reference Waveform (SPL of all frequencies, visually lined-up with spectrogram for quick reference)
⑦ Boxed selection in spectrogram, ready to be processed into an Audio Movie or Image (4.2.4)
⑧ Camera Controls: Start/Stop, Record, Gain (4.2.6)
⑨ Selection Processing options (4.4.2)
⑩ Realtime Settings (these controls may be adjusted only in Realtime Mode, “Stitch Depth” is set here and persists in recorded sessions) (4.3.2)
⑪ Image Settings (These controls effect the color gradient information shown in the Acoustic Image) (4.2.7)

⑫ Blue Position Line (This line demarcates the time focus of the session in the video window and the spectrogram; moving this line will alter the Time axis of the spectrogram)
⑬ Timeline Ruler (This area indicates the length of a recorded session as a timespan. The Blue Position Line indicates the current position in time in conjunction with the Ruler. The mouse can be used to select any range of time from this area (CTRL+hold left mouse button) to be displayed in the Video and Spectrogram Windows) (4.2.2)
⑭ Video Controls (Controls to Start/Stop video playback, turn HMD on/off (see VR Module), and change the POV of the Video Window)
⑮ Color Gradient Scale (This color bar indicates the SPL represented by a specific color in the spectrogram. The color-SPL relationship can be shifted by moving the slider to the right of the color bar in order to make target frequencies more visible in the Spectrogram) (4.2.4)
⑯ Acoustic Image Hotspot (Typical hotspot in the Acoustic Image indicating the location of a high SPL of some frequency) (4.4.2)
⑰ Drop Down Menu (This menu contains various options and extra module controls)

4.2 GUI Layout

4.2.1 Video Window (Center Screen)

The large center window shows the video with the overlaid gradient Acoustic Image. There are 3 view options for the video: Mercator (default view), Spherical, and Globe projections. (The Planar Array Device can only show the Mercator view)

While in Realtime mode, or when viewing recordings taken with the Audio/Visual Camera, the center of the video can be repositioned; click-and-hold on the video window in order to drag to the left or right. Clicking the button in the top right of the video window will put the panel into full screen mode, so it takes up the entire application window. (this button is transparent to minimize obstruction of the scene and is difficult to see)

While the Mercator view is generally the best way to see an Acoustic Image, there are specific situations in which other views can be preferred. In order to project a flat image, the Mercator view warps areas in the north and south poles (top and bottom). Sound sources in the warped regions will still be overlaid accurately, but it will be more difficult to translate those sources from the Video Window to the physical objects recorded. For this reason, it is recommended that the Spherical or Globe projections be used when important objects in the scene lie in the extreme top and bottom areas. (For example, when setup in a cramped location)

4.2.2. Timeline (Bottom-Center Box)

The “Timeline” represents a recorded video as a continuous waveform over its length. All frequencies are represented in the one waveform and it grows and shrinks relative to the total SPL in the recording. Inside the Timeline, a blue line marks the current position of the video. Above the Timeline are controls to play, stop, and jump around the video in time, as well as a display of the current position. The position of the video may also be fine-tuned; click and hold on the triangle above the blue marker and drag it back and forth to change the current position. The Spectrogram Window (4.2.4) and video will always stay in sync with the blue marker; in this way, different time segments of the video can be loaded into the Spectrogram Window for more detailed analysis.

Specific segments of the video may be selected by clicking in the Timeline Ruler (4.1 #13); while holding Ctrl, click and drag across and area to be analyzed; the selected area will appear in the Audio Spectrogram.

There are also toggle buttons to enable/disable the Virtual Reality Module  (4.6.1), and to switch the projection mode of the video  (4.2.1). In the bottom left, there is a gain display and volume meter for the final stereo output of the program 

. Click and drag the gain text to edit the output gain level; double-click the level meter to open volume controls in a separate window. The horizontal slider at the bottom can be used to look at different sections of the timeline. Clicking and holding on the end of the slider adjusts the timeline scale. Click and drag on the blue waveform icon between the volume meter and slider to adjust the height of the audio tracks and the height of the audio waveforms to see finer detail.

4.2.3 Control Panel (Bottom-Right)

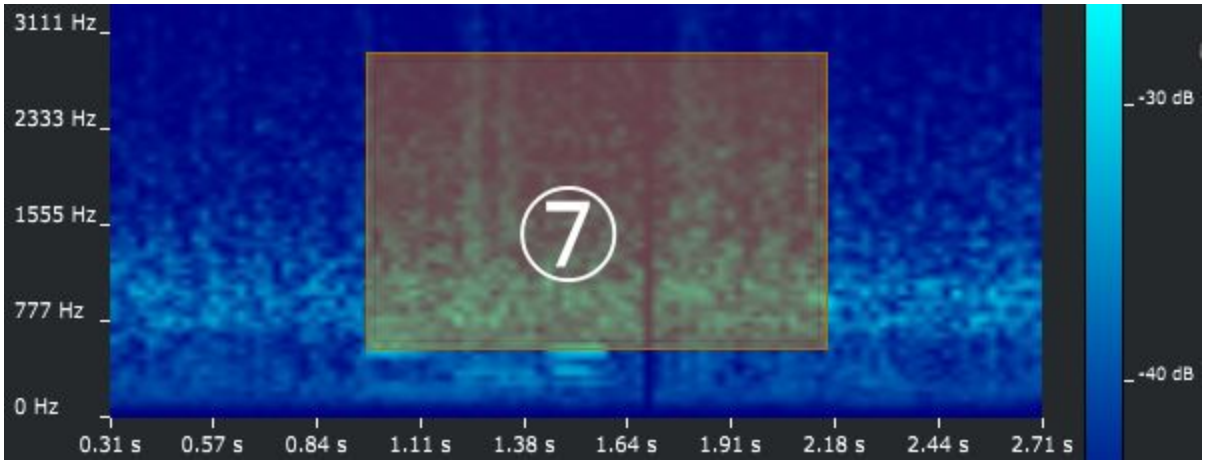
This window contains controls for Acoustic Image generation. It also has a separate Beamform tab to show the currently active beamforms. More information on how each of these controls affect the image can be found in sections 4.2.7 and 4.2.8. Beamform information can be found in section 4.3.2.

4.2.4 Spectrogram Window (Upper-Right)

When Realtime mode is active or a recorded session has been loaded, this window displays a color gradient spectrum indicating the SPL of all viewable frequencies (250Hz-7000 Hz) over time. The color guide on the right side of the spectrogram shows the specific SPL of a given color and may be adjusted with the vertical slider next to it. Sliding down/up will increase/decrease the gain of SPL across the entire frequency range in the spectrogram. Adjusting this slider can make all frequencies more visible by highlighting weaker frequencies and reducing the gradient noise of very loud frequencies. To zoom the visible frequency range of the Spectrogram Window in or out, use the mouse wheel while holding the cursor over the window.

- Selecting a Time/Frequency Range

From the spectrogram, users can select a time/frequency range for more detailed analysis of recorded sessions. An area of interest may be selected with the mouse; left-click and drag to draw a box in the spectrogram.



⑦ Boxed selection in spectrogram, ready to be processed into an Audio Movie or Image

The entire Spectrogram Window may be selected from to create a box. The selection box can be dragged around and resized by dragging the borders of the box. (Please note that, due to the physical limitations the actionable frequency range of the Audio/Visual Camera is 200 Hz to 7000 Hz)

The cursor position boxes show the current time and frequency at any given position of the cursor. Portions of the spectrogram may also be selected using the range text boxes or the ⅓ Octave Selection slider. To manually input a selection, click on the labeled white text boxes labelled “Time Range” and “Frequency Range” and type any values currently visible in the spectrogram. The 1⁄3 Octave Selection automatically selects frequency ranges in ⅓ octave bands and will scroll through bands one at a time. In order to use this method, a time range must first be set by drawing a box or inputting the time manually via the Time Range text box.

The time axis of the spectrogram is synced with, and adjusts in reference to, the Timeline Window (4.2.2). By default, the spectrogram displays a 3 second portion of a loaded session with the Blue Position Line in the Timeline Window as the central point. To alter the length of the time axis in the spectrogram, use the mouse to select an arbitrary range from the Timeline; left-click with the mouse while holding down CTRL and drag the cursor across any range in the Timeline Ruler to highlight the area.

- Processing a Selection

Below the spectrogram, in the box labeled “Process Selection,” are controls to compute an Audio Image or Audio Movie. Controls to play/stop an Audio Movie appear after one has been computed. See 4.4.2 for more details.

4.2.5 Session Browser (Upper/Lower Left)

The session browser has two components. The top portion displays the current directory and allows for the session directory to be changed to another location in your file system. The default directory is C:\Users\UserName\Documents\CameraSessions. The bottom area shows thumbnails of recorded Audio Camera sessions located in the current directory. Double clicking on any of the session thumbnails will close the current session and open the new session. The opened session name will be added to the title bar of the application.

4.2.6 Camera Controls (Right-Middle)

This contains the Start/Stop button, the Record button, and a drop-down menu which allows for the gain setting of the Audio Camera to be adjusted. This must be selected prior to starting the camera. Details of the gain settings are as follows:

a) -20 to -10 dB (signal saturates at approximately 129 dBFS)
b) -10 to 10 dB (signal saturates at approximately 115 dBFS)
c) 10 to 20 dB (signal saturates at approximately 95 dBFS)

Trigger button: See 4.6.3 External Triggering Module for more detail.

4.2.7 Acoustic Image Controls (Lower-Right)

The “Image Settings” box contains controls to manipulate the color gradient Acoustic Image in both Realtime mode and in a loaded session.

- “Generate Image” checkbox toggles the display of the overlaid Acoustic Image. If not checked, only stitched video will be visible in the video viewer.

- The “Max dB Displayed” slider controls the point at which the SPL will be displayed at “maximum” red in the color gradient Acoustic Image. For example, if you set the slider to 50dB, then any sound in the room louder than 50dB will be shown as red in the Image. Dragging this slider will disable the Auto Select button.

- With “Auto Select” checked, FINDr will search for the loudest frequency in the scene and auto-set the “Max dB” slider to that value. When it is selected, whether in Realtime mode or during playback of a recorded video, the “Max dB” slider will adjust as the SPL in the scene changes. Additionally, the “Threshold” slider will turn from grey to black and become unusable.

- The “Dynamic Range” slider defines the range of SPL that you will see in the Acoustic Image with the “Max dB Displayed” as the top value of that range. For example, if the “Max dB displayed” is set to 50, and the “Dynamic Range” is set to 20, then the Acoustic Image will display all received frequencies with a SPL of roughly 30 dB to 50 dB. Lowering the range will effectively narrow the appearance of “hotspots” (4.2.1 12) as the quieter outer edges will not be displayed, resulting in a tighter Audio Image.

- The “Threshold” slider provides a way set the lower bound of the dynamic range by simply setting the slider to the lowest volume sound that you want displayed in decibels. “Threshold” is only available when “Auto Select” is in use.

4.2.8 Realtime Controls

The Realtime Controls also affect the Acoustic Image, but are grouped here because they are most useful when using the camera in Realtime Mode.

- The “Frequency” slider alters the frequencies reported in the Acoustic Image in 500Hz ranges. The display window to the right of the slider reports the middle value of the range in Hz averaging 250Hz above and 250Hz below to generate the Audio Image. For example, if you place the slider all the way to the left, the value displayed will be “250Hz,” meaning the Acoustic Image is reporting frequencies from 0-500Hz.

- “Time Averaging” has the effect of smoothing out the refresh rate Acoustic Image by averaging the currently visible Acoustic Image “frame” together with those frames preceding it. Moving the slider to the left increases the effect of time averaging. This makes it easier to observe the changes in SPL in a scene, but also introduces some delay. Moving the slider to the right will show all the instantaneous sources and reflections captured by the camera but the visual cacophony can be overwhelming.

- The “Stitch Depth” slider changes the distance at which the camera images are properly stitched together in the Video Window. When the slider is moved all the way to the right, the cameras are stitching together at 20’ to infinity. When recording in a tight space, like the inside of a car, the slider will need to be adjusted until the video cameras edges line-up with each other at the distance of the suspected noise source. **The “Stitch Depth” slider must be set before making a recording to ensure the accuracy of the Audio Image overlay. This cannot be altered once a recording is made.**

4.3 Realtime Display

4.3.1 Starting the Camera

1. Connect your Audio Camera to the laptop running FINDr with the included USB 3.0 cable.
2. Connect the included power supply to your Audio camera and turn the power switch to the “on” position.
3. Open the FINDr software. The FINDr icon should be in the system tray on the bottom of your Windows 10 home screen.
4. Select the SPL range for your recording with the Camera Gain button, located in the Camera Controls box in the right-hand window of the FINDr software.
5. Click on the “Start Camera” button in the “Camera Controls” dialog box. The Audio Camera will take a few moments to start up so please be patient.

4.3.2 Realtime Mode

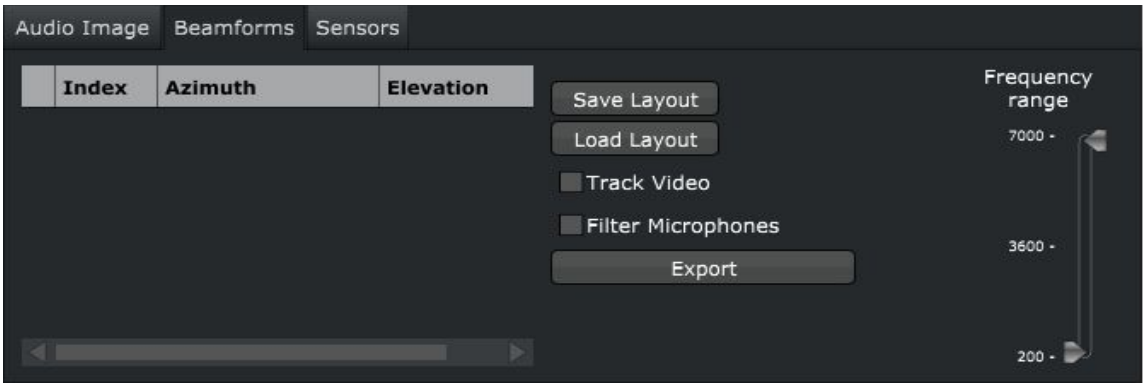
This mode is active when the camera is started in FINDr; the stitched video image and overlaid color gradient Acoustic Image will be visible in the Video Window. Use of the Control Panel functions allow for the Acoustic Image to be tweaked and can help to focus on frequencies of interest. Realtime mode can be used on its own to detect and analyze sound, but also serves to refine Acoustic Image settings in preparation for a recorded session.
A description of useful functions for Realtime Mode is in the sections which follow.

4.3.2.1 Beamforming with Virtual Microphones

While in Mercator projection, a double left click in the Video Window places a red dot in the Acoustic Image. The dot represents a virtual microphone with steered isolation of up to 24 dB, approximated using beamforming. Multiple virtual mics can be placed in the Video/Acoustic Image. Click and drag on the red dot to alter the position of a previously placed virtual microphone. Right click to remove the last virtual microphone placed. All virtual microphones will be combined into one track while listening in Realtime Mode.
The Beamforming tab in the Control Panel (4.2.3) houses the controls and display for the Virtual Microphone features.

The contents of the Beamforming tab are as follows:

- List of current virtual microphones including position
- Controls to Save/Load the current configuration of virtual microphones
- Enable/Disable Track Video. Only usable in Realtime Mode, this feature will identify objects in the video with virtual microphones placed on them and track those objects, moving the virtual microphones with them.
- Export button. When a recorded session is loaded, saves a *.wav file for each active virtual microphone, containing the processed directional audio.



4.3.2.2 Adjust Image Controls

Altering the Acoustic Image controls reveals more information about the location and intensity of sound in an environment. These controls make Realtime Mode a useful exploratory tool, and are instrumental in preparing for a recorded session. More information on the controls can be found in section 4.2.7 and 4.2.8.

4.3.3 Recording a Session

For detailed analysis of a sound scene, sessions can be recorded and processed according to user-defined SPL and frequency parameters.

Preparation for Recording:

1. Select camera gain setting from drop-down menu
2. Start Audio Camera in Realtime Mode
3. Set Stitch Depth to optimal distance; this is easiest when all areas of interest are within similar distances from the camera. Scenes with dramatic depths of field may require multiple recordings at different stitches
4. Set the maximum length of the recording; navigate in the Menu Bar to Options>Edit Record Parameters and enter length in seconds via text box.

Recording:

1. Click on Record
2. When prompted, enter a Session Name for your recording. Notice that the prompt also contains a calculation of remaining record-time based on the hard drive space on your destination drive
3. After giving the recording a prefix, a new session folder will be created in whatever folder is selected in the session browser, named with the prefix + the timestamp of the recording. The prefix entered will persist if a second recording is started, but a separate session will be created
4. After a Session Name is entered, the scene will begin to record; pressing the Stop button will cut the session short and save what has been recorded

4.4 Post Analysis

4.4.1 Loading a Session

Click on a session thumbnail in the Session Browser, or navigate from the Drop-down Menu to File>Open Session and browse to “session folder”>TestData. The application title bar will display the session name to

indicate that it is currently loaded. At this point, you can press the play button underneath the video window to begin playback of your selected video. Toggle the Realtime Settings and Image Settings to adjust the gradient audio overlay. Lowering the dynamic range will clean up the gradient and help to immediately pinpoint significant sound sources. (4.2.7- 4.2.8)

4.4.2. Processing a Selection

There are two options in FINDr for further analytic processing of recorded movies; they can both be found in the “Process Selection” window, underneath the spectrogram.

4.4.2.1 Creating an Audio Image

This takes a user-selected time and frequency range from a recorded session and creates a static image from data present in the range. The background image is the first frame of video in your selection and the color gradient in the image is an integration of all present frequencies averaged over time.

To create an Audio Image, select a time/frequency range in the Spectrogram Window (4.2.4), and then click Compute Audio Image, or navigate in the Menu Bar to Analyze->Compute Audio Image.

Audio Images can be saved as a jpeg image by navigating to Drop-down Menu>Analyze>Save Image.

4.4.2.2 Creating an Audio Movie

An Audio Movie computes the Acoustic Image for every block of audio, advancing by 32 samples at a time. This creates a granular frame-by-frame movie of a user-selected time/frequency range from the Spectrogram Window. Playing an Audio Movie can reveal the path of sound to the Camera and reflections in the scene.

To create an Audio Movie, select a time/frequency range in the Spectrogram Window (4.2.4), and then click Compute Audio Movie, or navigate in the Menu Bar to Analyze->Compute Audio Movie.

Once processed, a timeline bar and a “Play Movie” button will appear under the button. Click on Play Movie to start playback; Play Movie is then replaced with “Stop Movie” until playback is stopped. Drag the slider next to the play/stop button to find a specific frame in the movie. In the Spectrogram Window, a red line will appear in the selected range box, and with the Video Window, indicates the currently displayed frame in time. The Video Window is synced to position of the red line and displays the Audio Movie frame-by-frame. During playback, the frequency selection controls should not be altered and doing so will interfere with the computed Acoustic Image.

4.4.3 Exporting Results

Audio Images can be saved as a JPEG image to be included in reports. Navigate to the Drop-down Menu Analyze->Save Image, and choose a location for the output file. The image includes the title of the session, the video with Acoustic Image, and a legend to document the SPL-Color Gradient relationship selected for the image.

4.4.4 Batch Processing of Acoustic Images

The Batch Process feature outputs a series of Audio Images with user specified frequency and SPL characteristics. IFrom the drop-down menu, the Batch Processing feature is located under Analyze>Run Script. After selecting this option, you will be prompted to select a .csv script file. (please refer to the next section for

detailed information on how to create your script file) Once selected, the software will scroll through each line in the script and generate the specified images.

4.4.4.1 Creating a Script File

In order to complete Batch Processing sessions, FINDr requires an input script in the form of a CSV file to set parameters for any batch of images.
To create your script, write a CSV file in the exact format outlined below. Additionally, a sample file (batchProcessExample.csv) is located in the “Camera Sessions” folder on the D: drive of the included laptop. Please refer to this file for detailed formula information. Using the example file as a template, it is possible to swap out the batch details and file location information for any specific session. The script can be created using excel or google sheets. Once a script is created it must be saved as a .csv (comma separated variable) file.

Please Note:

-If there is an error in the script (for example, not enough parameters) the script interface will exit and not all images will be created.

-The Batch Processing feature of FINDr is especially memory intensive, and it is a limitation that only a set number of recordings can be opened within the script (eg “Source Directory” file in CSV). In order to limit the number of scripts opened, it is advised to group all images from a given session together.

SOURCE DIRECTORY	START TIME	END TIME	START FREQUENCY	END FREQUENCY	MAX dB	DYNAMIC RANGE	DESTINATION	SAVE NAME
D:\CameraSessions\test1-2019-03-06_12-11-49	1	1.1	1000	2000	AUTO	1	C:\Users\VisiSonicsD2\Documents\CameraSessions\	Image001.jpg
D:\CameraSessions\test1-2019-03-06_12-11-50	2	2.1	2000	3000	AUTO	1	C:\Users\VisiSonicsD2\Documents\CameraSessions\	Image002.jpg
D:\CameraSessions\test1-2019-03-06_12-11-51	3	3.1	3000	4000	AUTO	1	C:\Users\VisiSonicsD2\Documents\CameraSessions\	Image003.jpg

In the example script above, 3 images will be generated (one for each line) and stored in the destination folder with names image001.jpg, image002.jpg, and image 3.jpg. The source directory should be the root directory of a session recording.

4.5 Beamforming

Post analysis presents the option to export audio data from the location of Virtual Microphones placed in the Video Window of a loaded session. More information can be found in section 4.3.3.1.

4.6 Extra Modules

4.6.1 Virtual Reality

The program can be enabled to support watching the panoramic videos through a head mounted display, with full 3D head tracking for the video and perceptually accurate audio. The HMD is enabled by toggling the button in the timeline panel.

4.6.2 Order Analysis

This module allows spectro-temporal data to be mapped to harmonic order vs. RPM when tachometer data has also been acquired. This is most useful when dealing with rotating sub-assemblies.

4.6.3 External Triggering Module

This module includes a hardware adaptation adding a BNC connector to accept a triggering signal to start the recording remotely.

5. Technical Support Contact Information

VisiSonics Support Team prides itself on providing quality products and customer support. Should you have any questions or concerns on the set-up or operation of the Audio/Visual Camera after reading this user guide, contact VisiSonics. Thank you for your purchase.

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