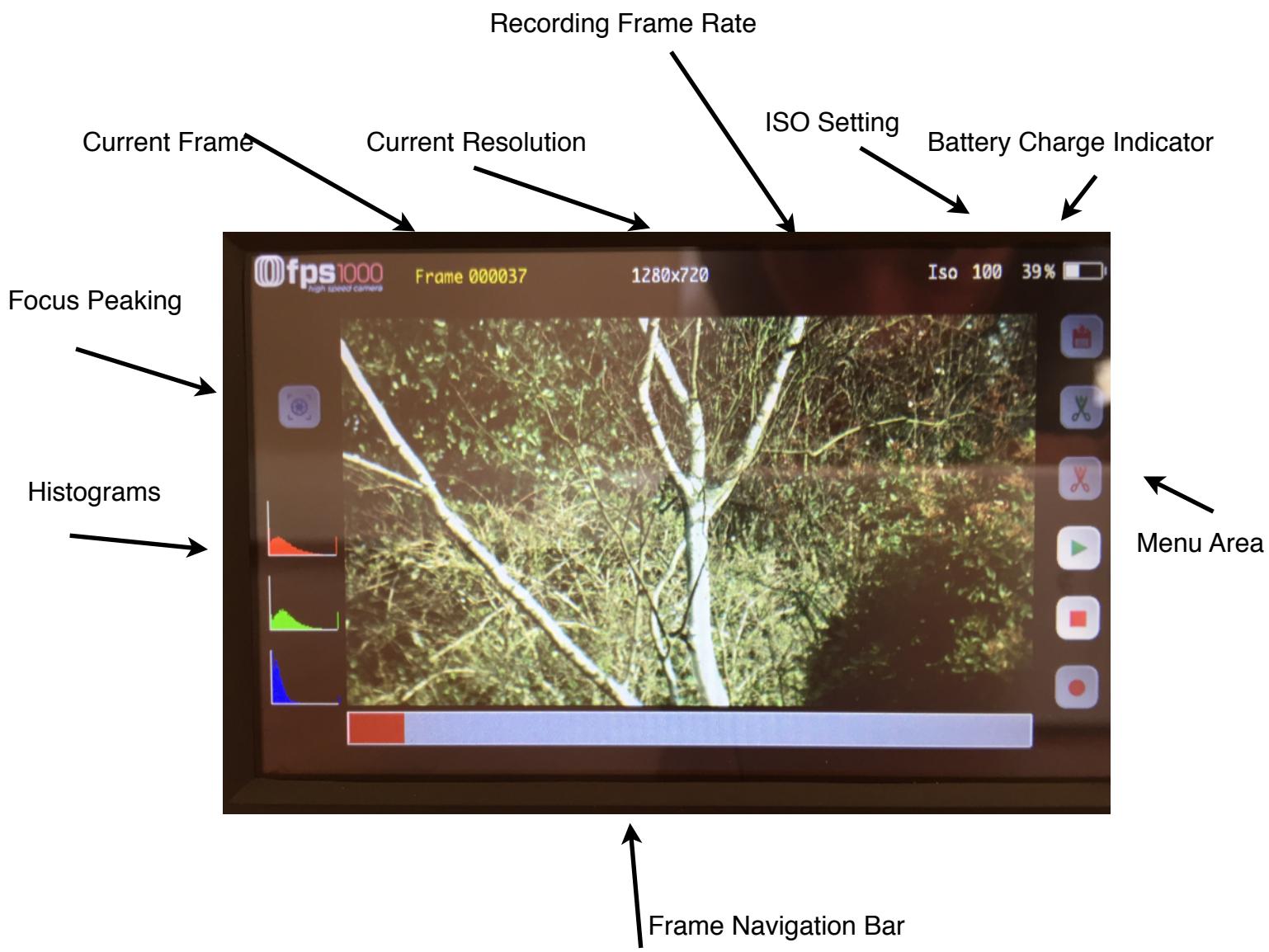
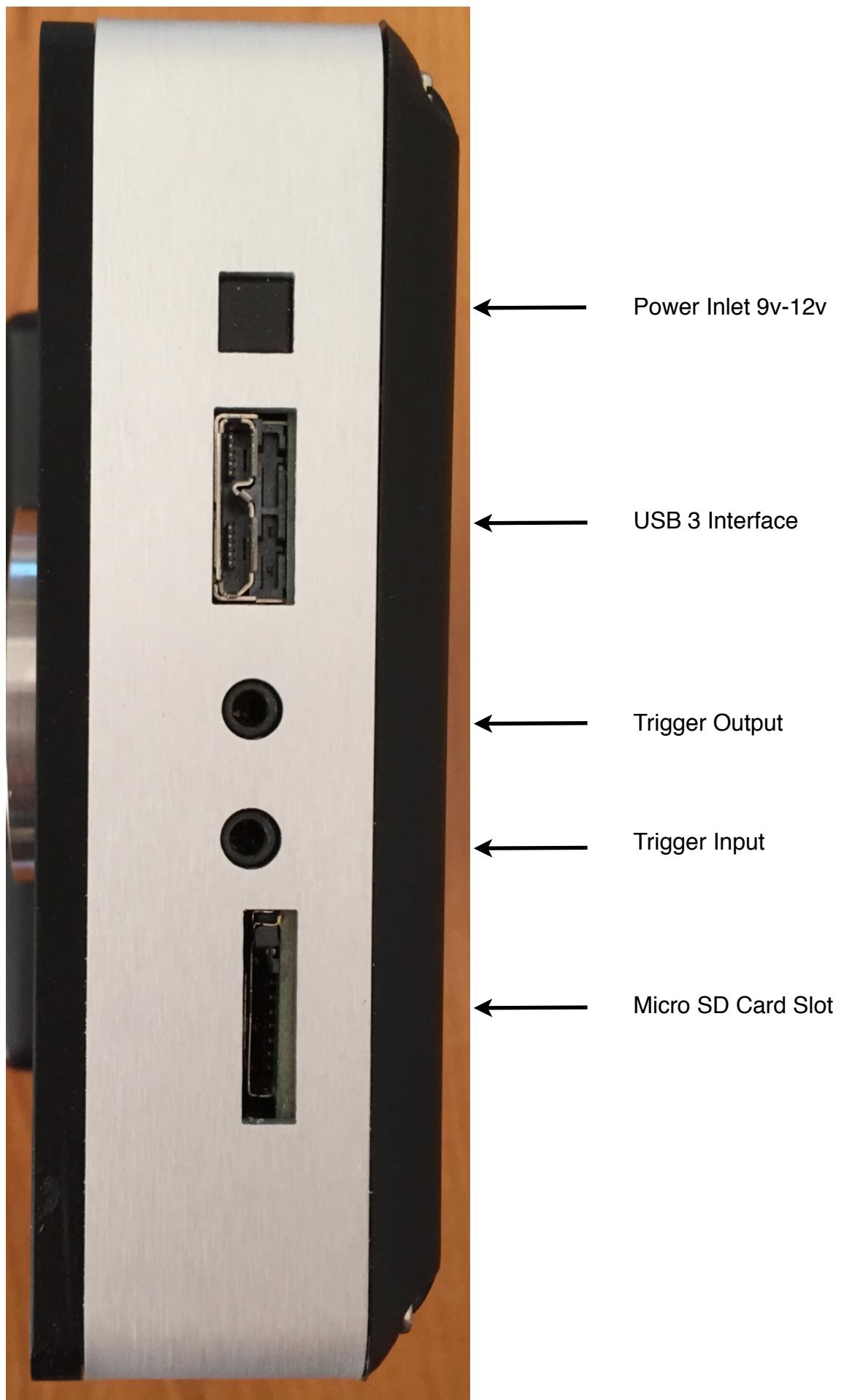


FPS 1000HD User Guide

May 5, 2017







General Notes

Thank you for purchasing the fps1000HD low cost high frame rate camera. We hope that you find the camera simple and rewarding to use. If you have any problems, comments or suggestions regarding any of the features of the camera then please contact us at support@theslowmotioncameracompany.com.

Please note that some of the features described here will be enabled with a future software upgrade.

The fps1000 runs from 2 Lithium Ion batteries. These are not supplied with the camera to avoid problems with shipping as Li-Ion batteries are potentially hazardous. These batteries are low cost and rechargeable. The batteries are designated 18650 and are 3.7v. There are many makes available - some perform better than others. Going for the highest capacity battery is not always the best strategy and it may be a case of trial and error. The batteries we have found to perform the best are LG HE41865 and Samsung INR18650.

Be careful to insert the batteries the correct way round. The positive side is marked inside the battery holder (positive side points towards the top of the camera). The batteries may be a tight fit initially so firm, but careful pressure may be required. The batteries should last for about 2 hours under normal use. **Under no conditions should you use a metal tool such as a screwdriver to remove the batteries. Shorting out the positive terminal to the metal battery case may cause the battery to catch fire.**

To switch the camera on, press the round black button at the top of the camera gently once. After a few seconds the LCD screen should light up. Total power up time is just a few seconds and the camera is ready to use.

To switch the camera off, press the same black button gently for 6 seconds.

The camera can be operated from an external power supply (not supplied). The recommended voltage range is 9-12v at 3Amps. The centre terminal is +ve.

FPS1000 Screen Layout

The screen is split into several areas. The central area is where you view the image for preview, record, playback and save. It represents a snapshot of what will be recorded or saved. It is a lower resolution version of the real image. It also previews and plays back at a slower frame rate than the real recording. *Please note that tearing may be seen while previewing and recording - this is because the preview cannot keep up with the high frame rate capture. This tearing is not seen in the recorded image which always records at the required frame rate.* The main screen area is also used during frame navigation during playback.

Menu Area

All operations of the camera are effected through the touch screen menus.

Frame Navigation Bar

The fps1000 has a large amount of high frame rate capture memory. This will typically be about 1 minute of real time recording depending on the model used. The memory can be partitioned so that recording and saving can be restricted to operate in a part of the memory. This is useful for saving recorded clips in memory before saving them to disk. Because of the large frame buffer memory a simple way of inspecting and navigating through the memory is provided. This is done using the Frame Navigation Bar.

The frame navigation bar represents the stored image memory. The leftmost side is frame 1 and the rightmost side is frame 32,000. When playing, recording or saving an image this bar can be used to navigate to the required frame and also indicates which frames are being recorded or saved. To navigate through the frames touch the bar or slide your finger along it. See the separate sections under record, replay and save for more details.

Information Area

At the top of the screen you can see various informational indicators. These show the remaining battery charge, the current ISO setting and the resolution. Other indicators appear under different use cases. The frame number is displayed during record, replay and save operations. It indicates the current frame within the total frame buffer memory which is being displayed. You will see a corresponding marker in the frame navigation bar to indicate where in the frame memory the frame appears. During recording operations the frame number indicator is red. During recording the frame rate indicator will be displayed - this is the measured recording rate in frames per second.

Histograms

These display the relative light levels seen by the sensor for each of the three primary colours. The vertical axis is a relative brightness measure. The horizontal axis is brightness level from zero on the left to full brightness on the right. The height of each bar in the histogram shows the relative number of pixels at each of the brightness levels. For the best exposure the histogram should be flat and wide, covering as many of the brightness levels as possible. If there is a peak to the left of the histogram, this indicates that light levels are poor. If the peak is to the right, it indicates that the exposure is too bright.



Erase

Before recording a clip the memory must be erased (a continuous recording mode will be available in a future software release). To erase the entire frame buffer memory follow these steps:

1. Press the record icon once (setting the camera into prime record).
2. Press the on/off button at the top of the camera.
3. With the on/off button still pressed, press the record icon again.
4. Release the on/off button.

The memory will be erased. The frame count will increment, displayed in white. The whole operation lasts a few seconds. During this operation don't keep the on/off button pressed for more than 6 seconds as this will cause the camera to turn off.



Record

There are two stages to recording. The first is a priming state. Press the record button once - this will show a highlighted state together with the stop button. The current frame indicator will be displayed in red. The camera is now ready to record.

To start recording, either press the record button again or press the power button once (and release it). To pause recording, press either the record button or the on/off button again.

Recording can be paused and resumed using this method. Pressing the stop button will exit the record mode.

You can bypass the priming stage by double clicking on the power button. This will start recording immediately.

During recording the frame rate indicator will increment showing which frame is being recorded into. The navigation bar will also indicate which area of memory is being recorded into. When recording is started a grey bar will show the extent of the selected region for recording and a red bar will show how much has been recorded.

When recording, the frame memory is incrementally erased automatically before the new image is recorded.

The frame buffer memory is non-volatile. When the camera is turned off the recorded images remain in the memory. When turning the camera back on the images can be replayed and saved as required. They will only be erased when new images are recorded over them.

The recorded region of the memory can be restricted using the cut in / cutout buttons. When the camera is primed for recording (single press of the record button) the start of the recorded region can be selected by touching a point on the frame navigation bar. A white bar will be shown on the frame navigation bar. To confirm this as the start record point press the green cut in button. The white bar will turn to green as confirmation. Then touch the point corresponding to the end frame on the frame navigation bar. A white bar will be shown. Press the red cut out button to confirm and the white bar will turn red.

With the record region restricted pressing the record button will start recording at the cut in point. When the cut out point is reached the recording will loop around to the beginning of the selected region.

If there is no selected recording region then the recording will start at the beginning of the frame memory and record to the end and then loop around to the beginning again.



Replay

Images stored in the frame buffer memory can be replayed through the LCD screen. Pressing the replay button will start replaying the images at 'normal' frame rates - ie images will be played in slow motion. The current playback frame number is shown in the frame number indicator.

During playback several frame navigation operations are possible. Touching the central viewing area will pause the playback. Touching or sliding a finger along the frame navigation bar will move to the selected frame. This is a quick way of navigating through the entire memory. For finer control, moving a finger left or right in the main area (swiping) will move the displayed frame a relative amount. Sliding a finger from left to right in the main area will cause the playback to move forwards and sliding a finger from right to left will play backwards. Sliding a finger slowly will step forwards or backwards with single frame precision. For faster movement swipe left or right and release - the replay will continue in the specified direction. The longer the swipe the faster the reply. You can touch the screen again to pause the replay.



Save

Any section of the recorded memory can be saved onto a micro SD card.

To prepare for a save operation, the section of memory to be saved must be selected. This is done using playback. Press the playback button to enter play mode. Then navigate to the start of the clip to be saved using the navigation controls described in the play section.

When the start position has been selected press the green cut-in button. The button will be highlighted and a small green vertical bar will appear at the selected point in the frame navigation bar. Then navigate to the end of the required clip in the same way. When the end point is reached, press the red cut-out button.

To save the selected clip press the save button. The region to be saved will be shown on the frame navigation bar as a grey strip. This will gradually turn yellow as frames are saved. The current frame that is being saved is displayed on the screen.

Note that saving to the SD card can be a long process due to the large number of frames being saved. Each frame is saved as a raw image without compression or loss of information. If you want to continue using the camera for more recording before the save operation is finished then you can pause the saving operation by pressing the save button. The save button will start to flash and the camera will exit the save mode. While save is paused you can use the camera to record new clips. You can define the recording area of the memory to be separate from the area being saved to avoid over-writing the clip being saved.

When you want to resume saving just press the save button again and saving will resume from where it was stopped.

Each new clip is saved into a separate numbered folder on the disk. Within the folder each frame is saved as a numbered image, the number being the frame number within the image memory of the saved image. This makes it easy to identify images in post processing.

If the save operation does not proceed then try ejecting and re-inserting the SD card.

fps1000 Workflow

The images saved from the fps1000 are raw. The advantage of a raw format is that all of the image information is saved in the file - there is no post-process compression or encoding preserving the full quality of the image.

However, raw files need to be processed and encoded before they can be viewed as a movie. The images are save as a single file per frame. The image format is DNG compatible (Adobe Digital Negative). These are in a raw format and will need to be passed through a converter to produce viewable image files. There are many programs available to do this and some of them are free. The one recommended is RawTherapee. This provides a number of debayering methods as well as a batch mode for converting the files to standard 16 bit PNG files. These files can then be read into a movie making program such as Adobe Premiere Pro or Apple's Final Cut Pro.



Cut In / Cut Out

These operations are used in conjunction with record and save operations to select regions of the frame buffer memory as described in the relevant sections.

When selecting a cut in / out point, pressing the cut in / out button once will select a point and pressing again at the same position will de-select it. You can navigate and press the buttons as many times as required to select the required point.



Stop

Use the stop button to stop any record, replay or save operation.



Focus Peaking

This is used during preview and record to assist with focusing. To select this operation press the focus peak button - it will be highlighted when enabled. Press again to turn this feature off.

When this feature is used, any sharp edges in the previewed image will be highlighted. This indicates that the edges are in focus. The highlights will not appear in the recorded image, it is for display purposes only, thus recording while this feature is enabled is perfectly harmless to the image.

Changing the ISO Setting

The fps1000 has 4 ISO settings: 100, 300, 600, 1200. 100 is the default setting. 600 and 1200 are experimental settings in this release of software.

To increase the setting touch just to the right of the ISO setting number (eg 100) at the top of the screen. You should see the number increment to the next setting as you do this. To decrease the setting touch to the left of the number. Touch the number itself to reset to 100.

It is best to use the lowest ISO setting as is possible as higher ISO settings increase the level noise in the images.

Changing Resolution

The frame rate of the fps1000 can be increased by reducing the resolution. The default resolution is 1280 x 720.

To change the resolution first touch the resolution information display at the top of the screen. The resolution display will flash red and white. Then select a new resolution by touching inside the main display area. As you move your finger left and right the horizontal resolution will change. Moving your finger up and down will change the vertical resolution. The selectable resolutions are restricted to allowable multiples.

Once the required resolution has been selected touch the resolution display again to confirm. The resolution display will turn yellow to confirm the selection and the camera will re-initialize with the chosen resolution - this will take a few seconds. After the camera has re-initialized the resolution display will turn white again.

With reduced resolution the frame rate will automatically be increased to the maximum frame rate possible at the chosen resolution.

The image on the LCD display will not always be an accurate representation of the actual recorded image due to the restricted resolution of the LCD display. This is especially true at higher resolutions. The recorded image will always be a high quality full resolution image.

Current resolution and frame rate options are:

1280 x 720 @ 1,000fps
1280 x 480 @ 1,500fps
1280 x 360 @ 2,000fps
1280 x 240 @ 3,000fps
1280 x 180 @ 4,000fps
1280 x 120 @ 5,000fps
1280 x 60 @ 8,000fps

640 x 360 @ 4,000fps
640 x 180 @ 8,000fps
640 x 120 @ 10,000fps
640 x 60 @ 20,000fps

Fixed Pattern Noise Removal

All CMOS sensors, such as the one used in the fps1000, produce noise in the form of faint vertical lines. These are caused by slight non-uniformities in the manufacturing process. These are not errors, as such, but simply a by-product of the manufacturing process of these devices. Fortunately this type of noise is constant and can be easily removed. Most digital cameras have a built-in mechanism for the removal of this noise and you would normally not be aware of the problem.

The fps1000 has automatic fixed pattern noise removal built in both for previewed images and saved images. The camera has been pre-calibrated before leaving the factory. If you see any noise bands or feel the camera needs re-calibrating.

Recalibration

Follow these steps carefully:

- 1) It is best to do this after the camera has been switched on for at least 5 minutes so that the sensor has reached a stable temperature.
- 2) Cover the lens with the lens cap so no light can get to the sensor.
- 3) Touch the fps1000 logo in the top left corner for at least 5 seconds - all buttons on the menu on the right will start to flash and you should see the message "select special function".
- 4) Release your finger from the logo. Touch the record button. You should see all menu buttons lit up.
- 5) You will see some flashing on the screen. The calibration progress is indicated by a message on the screen.
- 6) Wait for the calibration process to fully complete as indicated by the message.
- 7) Click the on/off button to exit the special calibration mode.
- 8) The calibration is complete - remove the lens cap.
- 9) Restart the camera.

The calibration is remembered so should not normally be repeated.

NB If the calibration is not set up or performed correctly (eg without the lens cap on) then incorrect images or a blank screen will result. If you have a blank screen then you can re-calibrate to see if this is the problem.

Removing the IR Cut Filter / Cleaning The Sensor

The fps1000 is fitted with an infra-red filter. The sensor is sensitive to infra red light from the sun - although this is not visible it affects the colour balance of images which will appear lacking in green. This can be removed if required in the following way. This is the same procedure for cleaning the filter and sensor.

1. Remove the lens.
2. Remove the 4 screws securing the lens holder to the front of the camera.
3. Underneath the lens holder you will find the filter - it is a circular glass disk about 1" in diameter.
4. Through the hole in the front panel you will be able to access the sensor.
5. Clean the filter and sensor using a camera sensor cleaning swab. These are readily available and are used for cleaning DSLR sensors. You should avoid touching the filter or sensor which will leave grease marks.
6. The filter does not need to be re-fitted if your application requires the removal of the filter. Most applications will require it.
7. Carefully place the filter over the hole in the front panel. It will just cover the hole. Only touch the edges of the filter to avoid grease marks on the filter.
8. Carefully place the lens mount over the filter. The filter should fit inside the recess on the underside of the lens mount. Gently move the lens mount from side to side a very small amount to ensure that the filter is seated correctly under the lens mount. With the filter correctly seated the lens mount will be in contact with the front of the camera all the way round.
9. Once the lens mount is positioned correctly over the filter align the 4 screw holes in the lens mount with the mating holes in the front of the camera.
10. Replace the 4 screws and tighten them.

Triggers

There are two 2.5mm jack sockets on the side of the camera - a trigger in and a trigger out. The simplest way of controlling the camera is to connect a standard camera trigger unit to the trigger input. Closing the two contacts of the trigger input will start recording and opening the contacts will stop. Alternatively a low voltage input can be applied. The camera automatically detects this type of trigger input and behaves accordingly.

Another way to control the camera is by generating a low voltage pulse on the trigger input. In this mode of operation the camera will grab a frame of video for every pulse it receives. This allows you to control the frame rate of the camera from an external unit and hence to synchronise or genlock the camera to an external source.

The fps1000HD also generates a low voltage trigger output pulse every time a frame is captured. This allows you to synchronise external lighting or other components to the capture rate.

By connecting the trigger output from one fps1000HD to the trigger input of another, the second camera will automatically synchronise itself to the first. In this mode the second camera will capture video in exact frame synchronisation with the first. Furthermore, in this mode you can control the recording of both cameras from the first - thus when you press record on the master camera, both cameras will start recording in exact frame lock.

USB Interface

To fps1000HD has a USB3 port which has 2 main functions.

Firstly, it allows the camera to be controlled from a host computer. For many applications the compact, hand-held camera is most suitable - where you want to be on the move and be prepared to snap anything that moves. However, many applications are in a controlled environment where the camera is set up on a mount focused on a fixed target. In many such applications the ability to control the camera remotely is required - for example filming explosions. You can send commands over the USB3 interface to control all aspects of the camera. Everything that is available from the touch screen is available via the USB3 interface.

The most powerful features are enabled by the streaming functionality of the USB3 from the camera to host computer. Video can be streamed from the camera and viewed live on a computer screen. This offers the advantages of a USB3 camera but with the added benefit of the high speed image capture into the in-camera memory. The streaming of image data is at standard video rates (30-60fps) and is not required to be at full video speed as is normal with most USB cameras.

There are many use cases for this streaming of video data. **First it can allow remote live preview of the target.** This, in conjunction with the USB3 control feature described above, means the camera can truly be used in a remote situation. It also allows the host computer to be used as a live preview monitor. The live preview is available before and during image capture.

Secondly, the playback in slow motion of captured images can be performed via the streaming interface. This also allows movement back and forth through the captured images at any speed to locate clips of interest. This mimics the interface available via the LCD touch screen.

Finally, the fast streaming of captured data means that images can be saved also at real video playback speeds. This is orders of magnitude faster than saving images onto the SD card. Raw video can be played back and saved at high speed.

fps1000 Controller App for PC

We provide an application that allows you to control the camera from a computer and to replay and save images from the camera's memory. This runs on PCs only initially but a Mac version is also planned.

Installation

First please install the USB driver software for the USB3 chip used in the fps1000. This is available at: <http://www.ftdichip.com/Drivers/D3XX.htm>. Your PC should have a USB3 port for best results.

The app is run by double clicking on the fps1000.exe program we supply on your SD card. The following files must be in the folder than the application is run from:

- fps1000.exe
- fps1000.exe.config
- FTD3XX_NET.dll
- FTD3XX.dll

The application interface appears and operates very much like the camera software. In the centre of the screen you have the main display which will display what you see on the camera's LCD screen. You should be able to see live preview from the camera when you start the app.

The app also has a menu bar at the top which mimics the controls on the camera. The status bar on the bottom shows the current settings. It also indicates which mode the camera is currently in - LiveView, Play, Record etc.

To play an image from the memory through the pc click on the Play icon on the toolbar at the top of the screen. You should see the images in the camera's memory being played back through on the PC's screen. You can pause the playback by clicking the Play button again. You can also navigate during playback using slider at the bottom of the screen. Just move the slider to move through the camera's memory. Press the Play button again to resume playing. You can also step one frame forwards or backwards using the pc's arrow keys (left and right). You can also jump through the video using the page down and page up keys (which jumps 100 frames at a time through the video). Press the Stop button to exit play mode.

You can select the cut in and cut out points by moving the slider to the required frame and then clicking on the CutIn or CutOut toolbar buttons. These apply to saving and recording. The blue bar on the slider shows the selected region.

Once cut in and out points have been set you can save images by clicking the Save button on the toolbar. This will bring up a folder selection menu. Select a folder where you want to save the images (you can create a new folder at the same time). Click OK and the images will be saved to your selected folder. You can select which file formats to save in by checking the relevant tick boxes on the toolbar. It is useful to save both JPG and DNG formats - JPGs are very small and give you a quick preview while the DNG files can be used later for full grading and higher quality images. PNG files are lossless and can also be used for raw grading. You can press the Stop button at any time to stop saving.

Known Issues with the Beta 1.0 Release

- It is recommended that you connect the fps1000 to the USB3 port of your computer before turning on the camera and running the controller app.
- Only 1280 x 720 resolution is supported initially.
- There is some image tearing on preview mode. This doesn't affect record and playback. It will be improved in a future release.
- Occasionally the camera will freeze. If this happens you will have to restart the camera.
- The PNG files are saved as 24 bit format. This will be improved to full 48 bit format.

Software Upgrades

To update the software with new releases as they become available, please follow these instructions carefully. The software update process should be smooth and relatively quick. However, if power is lost during the process then the camera can be rendered unusable. If this does happen then please contact support@theslowmotioncameracompany.com.

Begin by copying the new software release onto an SD card. The software release is provided in 3 parts. Not all releases will contain all files.

Part 1 - Main Software

This is always provided for a new release. It is called *fps1000ldr*. This is the software that runs on the DSP processor.

Part 2 - Mother board Firmware

This is provided in 2 files: *fp1mota.vme* and *fp1motd.vme*. It contains the firmware for the programmable logic on the motherboard.

It is not always needed.

Part 3 - Sensor board Firmware

This is provided in 2 files: *fp1sena.vme* and *fp1send.vme*. It contains the firmware for the programmable logic on the sensor board.

It is not always needed.

Copy all of the release software onto the SD card and place the card into the SD slot. This should remain in the slot throughout the entire process. Then follow this procedure carefully. You should read through the entire procedure first to become familiar with it.

1. Make sure the camera is switched off to begin and the batteries are fully charged. The upgrade process will not start unless the batteries have at least 50% charge.
2. Copy the upgrade files to an SD card. There are between 1 and 5 files.
3. Insert the SD card into the camera - leave it in there for the whole process.
4. Switch the camera on by pressing and releasing the power button. After 1-2 seconds of releasing the button, press it again and hold it down.
5. As soon as you see the *fps1000* logo appear in the top left of the screen, release the button. If you wait too long the camera will switch off and you will have to start again.
6. After you release the button you should get the message "Ready to update software - press power button briefly to confirm or hold it down to abort". If you do not see this message then eject and re-insert the SD card.
7. Press and release the power button to begin the first part of the process - upgrading the software.
8. You should see the prompt saying that the software is updating and it should automatically start. Do not switch the camera off during this process. It should only take about 20 seconds.
9. Wait for the screen to say that the software has been updated. You should get a message telling you to switch the camera off.
10. Switch off the camera (by holding the power button down for 6 seconds). Then repeat steps 4 to 8.
11. The software will update again as for the first time - it should say updated successfully. At this point if there are no more files to update (the motherboard and/or sensor board) the process is finished.

12. If the motherboard firmware needs updating you should see the message “fps1000 Motherboard firmware update”. This process will start automatically.
13. You should see some numbers being printed on the screen. Wait for this process to stop - it may take several minutes.
14. When it is finished you should see the message “Software updated successfully”.
15. Switch the camera off again. Follow instructions 4-8 again.
16. If the sensor board firmware is to be updated you should see the message “fps1000 Sensor Board Firmware Update”. This should automatically start.
17. Wait for the message "Software updated successfully".
18. Switch the camera off. The update process is now complete.

If you get anything wrong it shouldn't matter - you can repeat any steps. The important thing is not to switch the camera off at any time until the step is finished.

Please note the full upgrade process takes about 10 minutes.

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