Colorimetric and Resolution requirements of cameras

Alan Roberts

ADDENDUM 61 : tests on a Sony FCB-H10 mini-camera

Data for this section is taken from the specification and a very brief examination of a Sony FCB-H10 mini-camera (serial number 0079) as part of a group test of HDTV mini-cameras.

The camera is small (47.2x43.1x72.2mm) and weighs only 120 grammes, but the controller is relatively large and weighs about 1kg. The specification claims that it has a single CMOS sensor (⅓") and has a pixel count of about 2 million. It has an integral lens, 10x optical zoom (5.1 to 51mm) opening to F/1.8. Sensitivity is claimed to be 12 lux minimum illumination at F/1.8 for a 50% video signal, which is typical of camera with ⅓" sensors. It has only analogue output (component Y Pb Pr at HD, composite at SD), but the control unit has 3 HDSDI outputs. Control is via a separate control panel. There are minimal menus, allowing little of image control.

It can operate at 1080i (50 and 59.94Hz) and 720p (50 and 59.94Hz) and SD (NTSC and PAL).

Power consumption is 3.8 watts at 6 to 12V DC.

There are no controls on the camera itself. Unfortunately, the camera shows significant response to infra-red illumination.

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Menu and controls have not been listed here, there is little to record, however, the following items are controllable on the control unit.

1 Camera controls

Shutter	½ to 1/10,000 seconds in 21 steps
White balance	Auto, Indoor, Outdoor, One-push, Manual
Gain	Auto, Manual (-3dB to 18dB in 3dB steps)
AE control	Auto, Manual, Shutter priority, Iris priority, Bright, Spot AE
EV compensation	-10.5 to +10.5dB (in 1.5dB steps)
Backlight compensation	On, Off
Flicker cancel	Auto
Focusing system	Full auto (Normal AF, Intervak AF, Zoom trigger AF), One-push trigger, Manual, Infinity, Near limit setting
Picture effects	Nega art, Black & White, Picture freeze
Camera operation switch	Zoom tele, Zoom wide

2 Measurement results

All measurements were made by capturing video on a NanoFlash solid-state recorder using the HDSDI output from the control unit. Pictures were extracted for measurement using proprietary software for analysis.

2.1 Sensitivity

Sensitivity measurement was difficult, since the gamma curve clearly has a significant knee function, and thus finding a reliable measure for peak white was not sensible. The specification claims 12 lux at F/1.8 to achieve mid-grey, and so measurements were made at mid-grey. Exposing the camera to a 90% reflectance card (the white side of a Kodak Gray Card) at 1400 lux required an aperture of F/5.6 to get mid-grey. Thus, mid-grey should be achieved at F/6.7 with 2000 lux illuminance. Since, on a standard (ITU.709) gamma curve, 50% video is achieved by approximately 3.5 stops less exposure than peak white, it should take about F/1.8 to achieve peak white at 2000 lux.

2.2 Colour performance

Using a Colorchecker chart, the colour performance was judged to be reasonably acceptable. No individual colour stood out as being significantly wrong. This is fortunate, since there are no controls which affect colour performance.

2.3 Resolution and aliasing

All testing was done with a circular zone plate test chart having 6 sinusoidally modulated patterns. The six patterns explore luminance and chroma channels on the top row, RGB channels on the bottom row, the samples shown here are each only one quadrant of the luminance (grey scale) pattern.

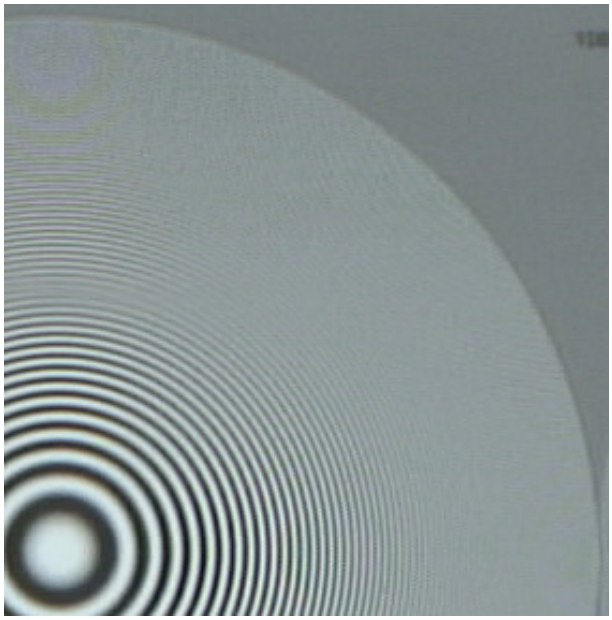

Figure 1 Resolution, 1080i

In 1080 interlaced mode, 1920x1080i/25 in EBU parlance, both horizontal and vertical aliasing is present although not at high levels. Since the achieved resolution is not particularly high either, it seems that the lens is the overriding limitation in this camera.

The aliasing is coloured, which is normal for single sensor, Bayer-patterned, cameras with 1920x1080 sensor. Clean resolution should reach 960x540 (the lower left quadrant of the pattern since that is the resolution of the red and blue Bayer pattern. Resolution up to 1920 and 1080 should be mutually exclusive, i.e. no increase in diagonal resolution beyond 960x540. The diagonal aliases are at low level, which confirms that the lens is the main limiting factor.

It was not possible to switch the camera into 720p or SDTV modes, since the available controller was, apparently, of an old design which operates only at 1080. nevertheless, the 1080 performance indicates that the 720p performance should be reasonably good, since there is little signal content above 1280x720.

2.4 Video Noise

The specification for noise performance claims ‘more than 50dB’.

Measurements were taken on an evenly lit white card, exposed at various levels. Image files were captured then decoded in software before performing a software noise analysis. The plot shows the noise level in dB versus video signal level.

The camera gain was set to 0dB, and the measurement files were high-pass filtered to remove any image shading and tilt, and 6dB gain applied to avoid any effects due to premature data quantising. So, 6dB compensation has been applied to the results, thus the graph is representative the camera performance at normal 0dB gain setting.

The result is extraordinary. It is very rare to find that each of red green and blue follow so closely in noise distribution. Also, it is extremely odd to find that noise levels are highest at mid-grey, since the normal distribution of noise follows the slope of the gamma curve, thus noise should be least near white, greatest near black, differing by about 13dB.

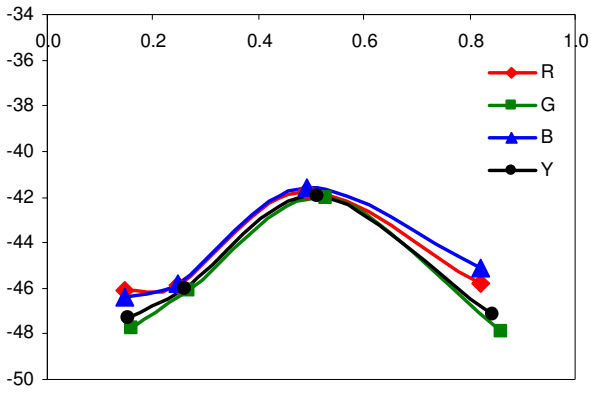

Figure 2 Noise at 1080i

One possible cause for this is that gamma correction is probably done on the analogue signals, before the adcs. If the amplifiers have limited gain-bandwidth product (which makes them cheaper), then the bandwidth will drop as the gain increases, towards black. This reduction will also cause a lowering of noise levels. The only other likely explanation is some form of noise reduction in the image processing, but the camera appears top be too simple for that to be true.

The level at mid-grey is about -41dB, which indicates that use of high-gain settings in the camera will not be very nice, but is quite adequate for a camera in this usage group.

2.5 Infra-red response

The camera responds to infra-red, as is usual for cameras of this type.