Colorimetric and Resolution requirements of cameras

Alan Roberts

ADDENDUM 29 : Assessment of a Canon HF10 AVCHD

The HD10 is a very small HDTV camcorder, weighing only 380grams. It records stills or television onto SD or SDHC cards using AVCHD compression (up to 17Mb/s, MPEG4), and can be monitored via an uncompressed HDMI connection. The range of menu controls is not adequate for broadcast purposes; clearly this camera is aimed at the consumer market. However, its performance is rather better than might be expected of such a small camera. Since the range of controls do not allow specific setting of gamma, detail and so on, only the colour performance and resolution has evaluated, and this document does not contain any listing of menu settings.

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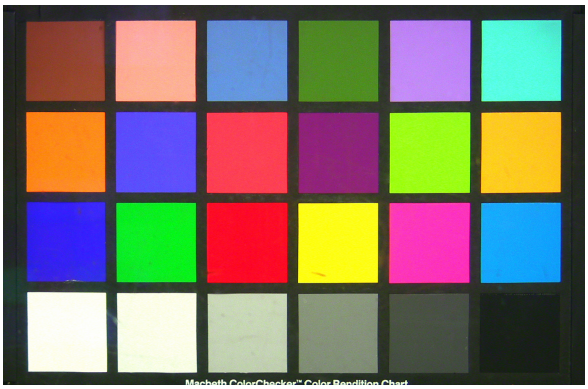
The HD10 is a very small HDTV camcorder, weighing only 380grams. It records stills with resolution up to 2048x1536, or HDTV (1920x1080) onto SD or SDHC cards using AVCHD compression (up to 17Mb/s, MPEG4), and can be monitored via an uncompressed HDMI connection. Since this is clearly a consumer camera, without the complex controls expected of a broadcast or professional camera, it was not possible to derive a set of BBC settings for it. However, its performance was sufficiently good to warrant close examination of the pictures, since it could easily be used alongside more complex cameras, in situations where its extreme small size is useful. Accordingly, this document does not contain any listing of menu settings. None of the camera's special image processing tricks were used during these tests.

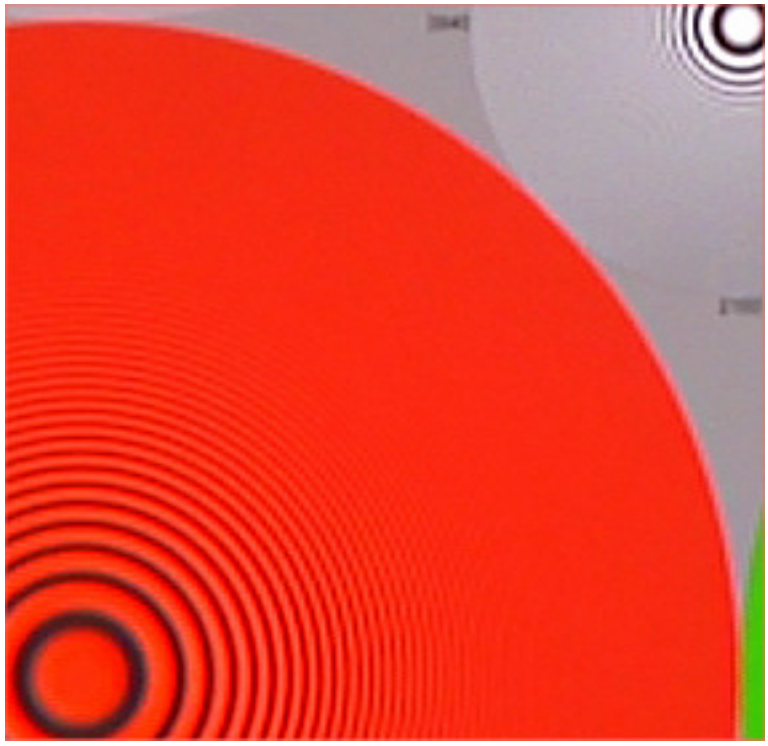
1 Colour performance



The camera was exposed to an illuminated Macbeth chart and monitored. via HDMI and a converter to HDSDI, on a large Sony HD crt monitor. Although colour performance was generally acceptable, the orange patches were low in saturation and the cyan patch (top left) was decidedly blue. Also, the yellow (third row) was rather green. No individual colour was unacceptable, and the whole could be expected to be tractable in a standard grading process.

2 Resolution

The camera specification says that the sensor is a single CMOS device, 1"/3.2 size, and 3.31Mpixels. It also states that the highest resolution still image it can record is 2048x1536, and this implies that the sensor has a 4:3 aspect ratio. The number of active pixels for the largest still frame is 2048*1536=3,145,728 pixels, implying that there are more pixels around the image, approximately 45 on each side, unused for imaging. The normal use for such "spare" pixels is as a source of information for automatic black level control, when they are covered by an opaque metal mask. Thus, the maximum image size is 2048x1536, and the HDTV signal is most likely pixel-mapped from a subset of these, 1920x1080.



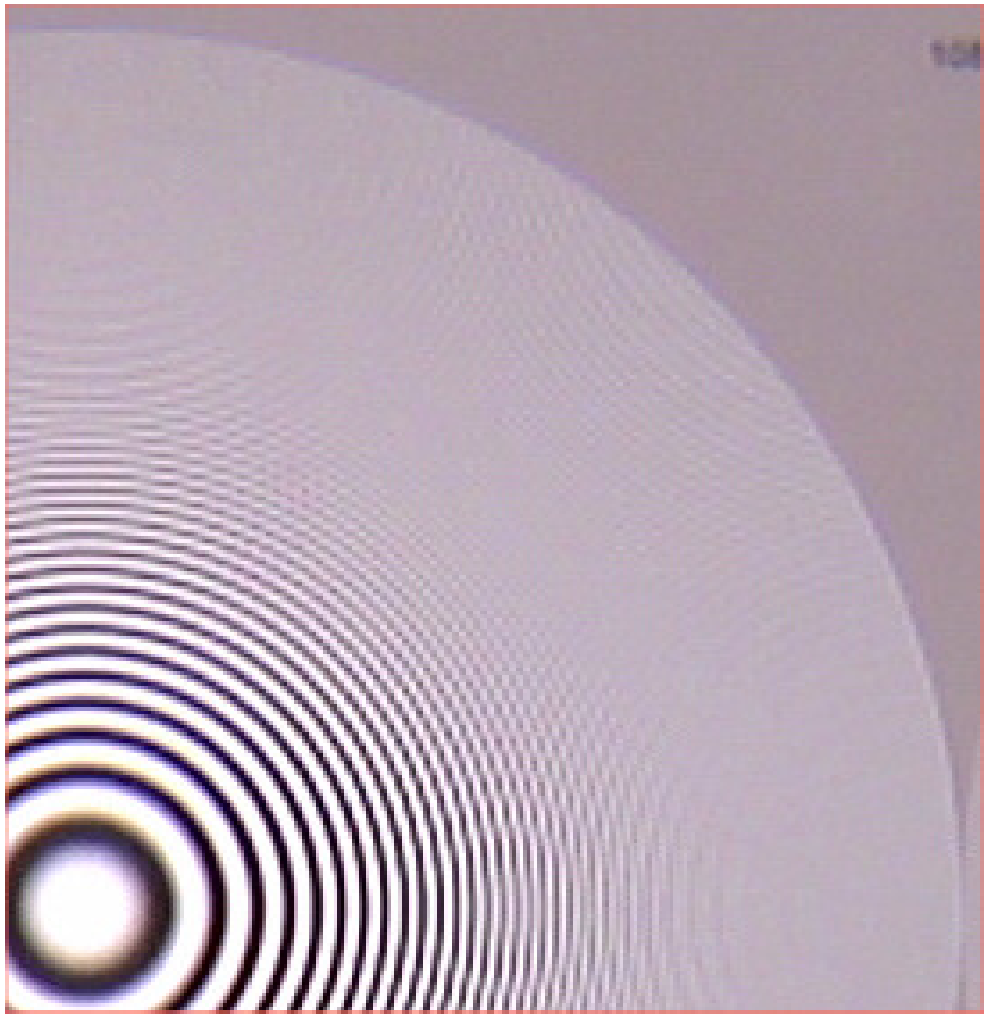
A coloured zone plate chart was used to explore resolution. This has 6 circular patterns, each exploring the frequency range of 1080-line HDTV, with dc in the middle, linearly moving to the maximum frequency at the rim in all directions. The chart has a pattern for each of luma, R G and B, and chroma channels.

Looking first at one quadrant of the red pattern, it is evident that the camera's red resolution limits are at about 960x540, half that of the 1920x1080 standard. Half way from the centre to the edge, horizontally and vertically, the sense of

the concentric circles reverses, this is to be expected from a Bayer-patterned sensor with a pattern of red and blue photo-sites of only half resolution. The folded frequencies, outside the clean 960x540 square, are fairly strongly reproduced, implying that there is no optical low-pass filter (bi-refringent) between the lens and the sensor. The strength of these aliases is rather less than on other, similar, cameras, possibly implying that the lens is not quite as sharp.

The blue pattern shows exactly the same effects.

The green pattern confirms all this, again only one quadrant is shown here. Since the Bayer pattern has green photo-sites on a diagonal matrix, instead of the square matrices of red and blue photo-sites (alternating with the red and blue), the resolution fills a diamond shape, or rather a square rotated by 45°. So, the "clean" resolution stretches to 1080 vertically but only when there is no horizontal detail, and to 1920 horizontally but only when there is no vertical detail. The resolution triangles outside the central square of 960x540 and reaching 1920 and 1080 respectively contain coloured aliases. This does not happen in the RGB signals, but in the transcoding and filtering to YP_bP_r components.



There is strong diagonal aliasing, because all three sensor patterns produce aliases on diagonals.

The luma pattern shows the overall result. The central 960x540 square is clean, there are coloured aliases in the outer triangles reaching 1920 and 1080, and strong luma aliases on the diagonals. Again, this is normal for Bayer-patterned cameras.

The presence of these aliases, or folded frequencies, can caused confusion in motion-sensitive coders, such as MPEG2 and MPEG4, because some parts of edges will move in the opposite direction to other parts when the image moves.

This confuses the motion detector and results in either excessive data rates or excessive compression artefacts. Either way, they should be avoided if the best quality pictures are demanded.

That said, the performance of this camera is better than most cameras tested in this class, probably because the lens is a little softer than in the others.

A recording was made of the zone plate pattern (AVCHD, MPEG4, H.264 at 17Mb/s); it did not show any significant degradation of the image.

3 Motion

The motion performance of the compressor was not tested during this evaluation. However, MPEG4 with a data rate of 17Mb/s should be approximately equivalent to that of MPEG2 at about 30Mb/s with the same resolution input. But, this camera records 1920x1080 while HDV (the nearest equivalent consumer compression system) records only 1440x1080, so the HF10 should be expected to use about 30% more bit rate, all other things being equal. So, the 17Mb/s data rate of this camera would be equivalent to about 13Mb/s at 1440x1080, roughly equivalent to the 25Mb/s of HDV, but delivering sharper pictures.