

4 The Technology of a Digital Camera

PART A The Digital Controls

Digital cameras have optical setting controls (such as aperture, shutter speed and focus) and digital setting controls. This Supplement deals with the digital setting controls. For general photographic advice, including the optical controls, see Supplement **1 Taking Good Photographs in a Church**. Camera models vary in their controls. You might need to look into the user manual for your camera to find out how to make the settings described below.

Quality settings

All digital cameras will capture images in JPEG format. Some have the alternatives of TIFF or RAW formats. For more details see **PART B Understanding Photographic File Formats** below.

Most CR photographers will take in JPEG format. The setting should be 5 megapixels or more and, if there are quality settings, choose superfine or finest.

If the camera will take in TIFF format, use that because it is the standard format for Church Recording. There is no expectation that you take in RAW, but, if you are familiar with it, use it if you wish.

Aspect Ratio

Many digital cameras allow you to choose the proportions (the aspect ratio) of the photographs. This means the width and height expressed as a ratio. The common ones for church recording work are 3:2 or 4:3. Choose whichever shape you would like the pictures to be. 3:2 could be a 6" x 4" print. 4:3 could be 5" x 3.75" or 6" x 4.5". See Suppl. **7 PART B The Photographs**.

ISO

Broadly, the higher the ISO number, the more sensitive the camera is to light, so pictures can be taken in lower light or with faster shutter speeds and smaller apertures. However, it works electronically more like the volume control on a radio, so when the ISO setting is raised, everything is amplified, including background 'noise*', which is undesirable. For this reason, work with the lowest ISO setting at which you can get a clear picture – 100 or 200 ISO. Try not to go above 400 ISO unless you have a semi-professional camera with a large sensor. The advantage of church recording photography is that the subjects don't move! This means that you can use long exposures, and digital cameras can capture amazingly good pictures in low light with long exposures of 30 seconds or more. For this it is essential that you work with a tripod.

Do not be tempted to use an 'Automatic ISO' setting, as this will tend to select a higher ISO setting than is desirable for church recording, resulting in higher digital noise* levels.

**a speckling effect on the picture.*

White Balance

This setting allows the camera to adapt its colour palette to allow for the differences in the colour of light between e.g. bright sunlight, overcast, tungsten or fluorescent lighting. On many cameras, the automatic white balance setting does a remarkably good job. Alternatively, setting the camera to the type of light conditions may produce a more accurate result. In particularly difficult lighting, it can be worth setting a 'custom white balance' using a standard 18% grey card or even a sheet of white (not cream!) paper and following the instructions in the camera manual.

Image stabilisation

Most digital cameras have some form of image stabilisation – either built into the lens or the camera body. This counteracts camera shake and is designed to allow handheld shots to be taken successfully with 2-4 stops longer exposures than would be the case without them. But, some systems increase the ISO setting and others reduce the available pixels, in either

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case degrading the picture. You will always produce a better image using a tripod than shooting handheld. Also, when using a tripod, the image stabilisation system is confused and can actually introduce blur.

Switch off image stabilisation unless you are absolutely obliged to take a shot handheld in poor light.

Aperture (f number) and Shutter speed Digital cameras calculate and balance three variables to give a good exposure – ISO (see above), Aperture (size of the opening admitting light) and Shutter speed (the length of the exposure in seconds and fractions of a second). Cameras usually have a control wheel or lever which allows you to select between Auto (sometimes iA), P (Programme – semi automatic), A (Aperture priority), S (Shutter priority) or M (Manual) modes of operation. (Sometimes slightly different letters are used).

Often, a satisfactory picture can be taken using the Auto mode. On the other hand, experienced users might well use Manual mode for some or all of the time, setting all 3 variables to suit the circumstances, guided by a light meter.

For Church Recording, Aperture Priority is very useful, when combined with a low ISO setting (see above). This allows you to select an aperture to provide the depth of field to suit the subject and acquire enough light (the higher the f number the greater the depth of field). It allows the camera to choose the shutter speed for best exposure at the given ISO setting and aperture.

However, if you are not confident with setting an appropriate aperture, then select a low ISO number and use the P setting.

Shutter priority is primarily for capturing moving objects and unlikely to be used for our purposes.

Flash

On-camera flash is rarely useful for church recording as it reflects into the camera and flattens detail, so be sure you know how to turn it off – and avoid the ‘automatic flash’ setting which always fires the flash in low light. Using a tripod, a low ISO setting and a longer exposure without flash will almost always give much better results. A reflector to bounce light into dark areas can help a great deal. If more light is still needed, see **PS1 Taking Good Photographs in a Church.**

Scene modes

Increasingly digital camera makers are including all sorts of pre-programmed ‘scene’ modes – for portraits, landscapes, night time shots, sepia images etc., enhancing the picture artificially. Generally avoid these and use the most standard or straightforward setting.

Histogram and exposure compensation

If your camera has a histogram display, it can be a very useful way to ensure that you get good exposures, so it is worth time learning how to interpret it from your camera manual. There is likely to be an exposure compensation control somewhere on your camera. This allows you to adjust the way the camera calculates the apparently ‘correct’ exposure, and to produce a lighter or darker image.

In taking an image with high contrast, there is a danger of losing detail in shadows and ‘blown’ highlights. In digital images, it is easier to recover detail in shadows than in highlights, so many photographers keep the exposure compensation set to slightly underexpose the image.

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When photographing objects against a dark background (e.g. a black cloth), set the exposure compensation to underexpose by a stop or so, otherwise the camera will try to show too much detail in the background which will appear grey. Conversely, when photographing against a light background (e.g. silver items) overexpose by a stop or so, so that the background is white and not grey.

If you can read the histogram, aim to get the right-hand side of the curve to fall just inside the diagram. Too far to the right and the highlights will be burnt out.

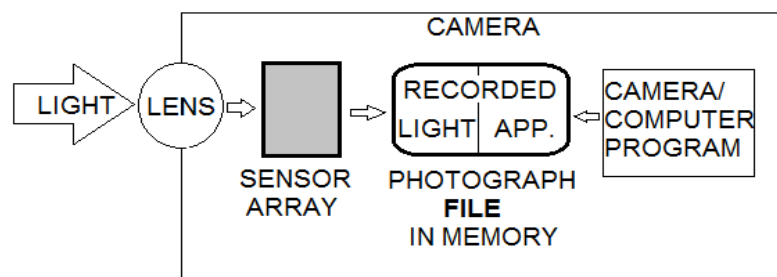
Digital zoom

Optical zoom is a true image enlarged through the lens. Digital zoom is artificial and should not be used.

PART B Understanding Photographic File Formats

A photograph recorded digitally in the memory of a camera or computer is a **file**. The file is recorded in one of several **formats**. Those used in church recording are JPEG, TIFF and RAW. Consider JPEG and TIFF files as having 2 components. One is the picture as captured by light receiving sensors. The other is application software which makes the picture file saveable, process-able and useable.

Diagrammatically the components of the file could be thought of:



JPEG

The commonest format. JPEG files are compressed in order to save on memory use. In everyday use a JPEG file takes from 500 kilobytes to 3 megabytes of memory, because the application side of the file is small. JPEG compression works by identifying blocks of pixels which are very similar and saving only one copy of the block. The disadvantage is that this process is repeated each time a JPEG file is opened and saved again. As a consequence fine detail is discarded, which causes progressive degradation of the image and the introduction of 'blocky' or banded artefacts.

For this reason, images taken with a digital camera in JPEG for Church Recording *must* be converted to TIFF format (see below) *before* any editing and further saving is done. This can be done by opening the original JPEG file on the computer, using the 'Save as...' command, and selecting TIFF as the file format. (For advice on converting quantities of files from JPEG to TIFF in batches see Suppl. **5 Changing File Formats and File Sizes**).

So called "lossless JPEG" is not an alternative to truly lossless TIFF.

TIFF

The TIFF format uses a form of compression that is 'lossless' – meaning that all the data are retained and unpacked each time the file is opened and nothing is lost in the process. Quality is maintained whilst editing. However, TIFF files occupy much more memory than JPEG files because of the sophisticated application side.

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RAW

Each camera manufacturer has its own recipe for making images taken with its cameras appear as attractive as possible – e.g. by automatically adjusting the white balance, contrast, and sharpness of the images - before saving them in JPEG or TIFF format. This is inevitably a subjective process and therefore some experienced photographers prefer to work with RAW files rather than the manufacturer's enhancement.

A RAW file is only the electronic picture record captured in by the sensors and recorded as **pixels**. Nothing is added or adjusted automatically by the camera. If you have the right software and skills, it is then possible to adjust the white balance, temperature, contrast, sharpness etc. according to your criteria rather than the manufacturer's, and then to save the results as TIFF files. This involves some investment in suitable software and time and is not a requirement for Church Recording. However, if you are used to working in this way, it is satisfactory.

Conversion between formats

After any adjustments, RAW files must be saved in TIFF format.

For bulk conversion from JPEG to TIFF see **PS5 Changing File Formats and File Sizes**.

PART C Understanding Photographic File Sizes

Digital images, as captured by a camera's array of light sensors, are made up of **pixels** – 'picture elements' or dots of a given colour and brightness.

The size of a digital image can be expressed either in terms its **pixel dimensions** (the total number of pixels or megapixels), or its **physical dimensions** when viewed on a screen or printed.

Pixel dimensions

Most digital cameras these days are capable of capturing images of at least 5 megapixels (5 MP = five million pixels). This is satisfactory for NADFAS Church Recording. A 4:3 image that is 2560 pixels in width and 1920 pixels in height is 4,915,200 pixels, which, rounded up, is 5 MP.

The quality and accuracy of a picture printed or on a screen depends upon the density of the pixels. This is usually measured in pixels per inch (ppi), measuring along the width and the height of the print or picture on screen. Typically, a computer monitor uses 72 ppi and, on screen, the picture can be crisp and bright (but you do not have to look hard to see the dots).

For Church Recording, 300ppi is the standard to aim for and 250ppi the minimum.

Also note that if a 300ppi image is cropped (say 6" x 4" to 5" x 3.33") and the cropped image enlarged (e.g. back to 6" x 4") the ppi will be reduced. If this is planned, the camera should be set at more than 5MP (say 10MP) to allow a good margin for the cropping and enlargement.

The size of photograph files

For Church Recording we are concerned in the first place with the *pixel dimensions* of the images, which determine the level of detail visible. The level of detail is important to allow scholars and researchers to examine the artefacts closely on screen or in print. *To provide sufficient detail, images from a camera should contain a minimum of 5MP.*

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Images that are smaller than this must not be resized to make them larger. Detail that is not present in the image cannot be recovered by enlarging the file. The process creates extra pixels artificially.

In Church Recording there are 2 objectives:

- for the photograph archives of Historic England, ChurchCare Library and equivalent bodies who want them, TIFF format photographs which will make an excellent, accurate print at 9" x 6" (3:2 ratio) or 9" x 6.75" (4:3 ratio) physical dimensions. The longer side of the photograph should measure 2,700 pixels i.e. 9" x 300 pixels; and
- for the copies of the whole Record in digital form or printed, JPEG format photographs the longer side of which should measure 1,500 - 1,800 pixels, equating to a photograph the longer side of which is likely to be 5" or 6" in most cases. Reduced file size JPEGs are used. PDF/A presentations of the photographs are created from these.

Maximum size of image files

Very roughly, a 5MP JPEG picture might occupy 3.5 megabytes (MB) of memory. Saved in TIFF format at 2,700 pixels long side it might occupy 15MB because of the cleverer format of a TIFF. A 10MB RAW photograph might become 30MB saved in TIFF format.

Some mid-range cameras these days can produce JPEG images approaching 20 MP, equivalent to a very large number of megabytes of memory when saved in TIFF format.

Exceeding 20MB in TIFF, the photograph is above the standard required, will occupy more memory or disc space than necessary and will be slower in use. An uncropped photograph less than 10MB in TIFF is below the standard. The ideal is between 10 and 15MB and 15 to 20MB is okay.

Some computer memory/disc space can be saved by using a clever form of compression on TIFF files – this is known as LZW compression and does not cause the loss of detail found with JPEG compression. LZW compression will reduce file sizes by 20-30%, depending on the level of fine detail in the image. A TIFF file of 7 to 8MB would still be satisfactory.

If it is found that image files are in excess of 20 megabytes, they should be resized, ideally to a size of 10-15 megabytes each, before saving on a memory stick or the archival CDs (whichever is specified). This can be done quite simply using a batch process – see **PS5 Changing File Formats and File Sizes**

Applying the Digital Photographs

The 10-20MB TIFFs are burned onto a memory stick or a set of archival CDs as described in **PS6 Supplying the TIFF Photographs to Historic England and other bodies in digital form** and **PS7 Part F**.

An identical set of identically numbered photographs of approximately 1-3MB in JPEG format is used for producing for the full Record (i) the photo pages and embedded photographs saved in PDF/A, (ii) photographic prints, if required and (iii) section folders of JPEG photographs for memory sticks and archival CDs. See **PS7 Compiling the complete Record and delivery in printed and digital forms**.