Forensic Image Comparison and Interpretation Evidence: Guidance for Prosecutors and Investigators

Issue 2

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1. Purpose

The purpose of this document is to provide advice and guidance for prosecutors and investigators in the effective use of image comparison and interpretation as expert forensic evidence. The document will provide background on the different types of comparison and interpretation evidence, factors that affect the reliability of this type of analysis, the requirements of the Forensic Science Regulator and the Criminal Justice System regarding expert evidence and points to consider when commissioning experts.

2. Image Interpretation and Comparison as Expert Evidence

2.1. Introduction

The enhancement and comparison of photographic or video images obtained in the course of an investigation can, in certain circumstances, be of assistance to a court in deciding the issues in a case, such as the presence of an accused person or suspect vehicle at the scene of a crime. The use of scientific techniques to enhance, compare and interpret this evidence means that it is treated as analytical forensic evidence and, insofar as it calls for the opinion of a person specialising in such techniques, it is treated as expert evidence for the purposes of the Criminal Justice System (CJS).

2.2. Requirements of the CJS and the Regulator

Since its initial use in UK courts over twenty years ago, the field of facial image comparison and image interpretation in general has been poorly regulated with no external accreditation. The UK Forensic Science Regulator ('the Regulator') has established Codes of Practice and quality standards in order to ensure the reliability of forensic science evidence. As an analytical forensic science, expert image interpretation and comparison is governed by the Regulator's Codes of Practice. The over-arching Codes of Practice and Conduct for Forensic Service Providers is available at the following link:

https://www.gov.uk/government/publications/forensic-science-providers-codes-of-practice-and-conduct-2016

Additional guidance specific to the examination and analysis of video and image material can be found in the Video Analysis: Codes of Practice for Forensic Service appendix, available from:

https://www.gov.uk/government/publications/video-analysis-codes-of-practice-for-forensic-service-providers

In addition to the Regulator's codes, image interpretation evidence must also meet the procedural requirements of the CJS as set out in the Criminal Procedure Rules and Criminal Practice Directions. Those providing such evidence for use by the Crown Prosecution Service in England and Wales must comply with its Core Foundation Principles for Forensic Science Providers, available at the following link:

http://www.cps.gov.uk/legal/s_to_u/scientific_evidence/core_foundation_principles_for_forensic_science_providers/

Unlike other established forensic disciplines such as DNA profiling the comparison of faces (and in some circumstances the interpretation of images) is an innate skill in all humans which will vary between different individuals. Some people are naturally very good, others are not. However, this natural ability differs from the use of facial image comparison and image interpretation as forensic science evidence. If image interpretation or comparison is utilised as forensic science evidence, the forensic expert who has undertaken the work must demonstrate the following quality standards expected by the CJS, as set out by the Regulator (and incorporating common law principles regarding the admissibility of expert opinion):

- The expert has expert knowledge and ability, acquired through a documented process of training and testing, which qualifies them to provide expert evidence beyond the knowledge and abilities of a lay person.
- The expert has followed an analytical process that has been documented and can be repeated by another suitably qualified expert.
- The methods and processes used during the comparison process have been validated to such an extent that the limitations are known and that they are suitable for the purpose for which they are used.
- The evidence has undergone a process of peer review and/or verification whereby the findings of the expert have been checked and/or verified by another competent expert.
- The work meets the requirements of the CJS in relation to providing impartial, unbiased advice to the court.
- The analysis and the reporting of the work complies with the requirements of the CJS in relation to the expertise of those involved, record keeping, disclosure and the form and content of reports.

Simply citing years of experience and stating that the type of evidence has been previously accepted by the courts is insufficient to ensure that the expert is competent and their analysis and conclusions are reliable.

3. Technical Processes and Subjective Interpretation

3.1. Image Comparison and Interpretation Tasks

Imagery (video and still images) can come from a wide range of different media, such as CCTV recorders, smart phones, webcams, camcorders and social media websites. Image based evidence can provide a number of investigative opportunities and potential for expert forensic interpretation. Typically expert interpretation of image based evidence concerns the identification or exclusion of a subject depicted within the imagery. Common methods for identification include:

- Facial Image Comparison
- Clothing Comparison
- Gait Analysis
- Vehicle Identification/Comparison
- Object Comparison

For each of these methods observations of a disputed subject from the imagery will be compared to reference imagery of a known subject to determine if there are any apparent differences or similarities between them. The expert will then provide a subjective opinion as to whether their findings support the disputed and known subjects being the same subject or different subjects, the consideration of more than one proposition when evaluating findings is important as a means of demonstrating impartiality by the expert. If the expert only considers one explanation for their findings the results may be biased towards a particular outcome.

In certain circumstances (most commonly, when there is a clear image for comparison with the reference image), it may be appropriate to simply show the disputed imagery directly to the judge and jury without the need for expert interpretation, which can be clarified by an initial triage of the imagery by a competent forensic image analyst. If there are issues with the imagery that warrant analysis and interpretation by an expert witness, experts must demonstrate that they have followed a validated methodology in all parts of their analysis, which is proven to be reliable and repeatable and their findings have been reviewed by another suitably qualified expert. Experts must also demonstrate that they are competent to carry out all parts of their analysis.

3.2. Workflow

Image interpretation tasks, such as facial image comparison, can be broadly defined as both a technical process and a subjective analysis (see Figure 1).

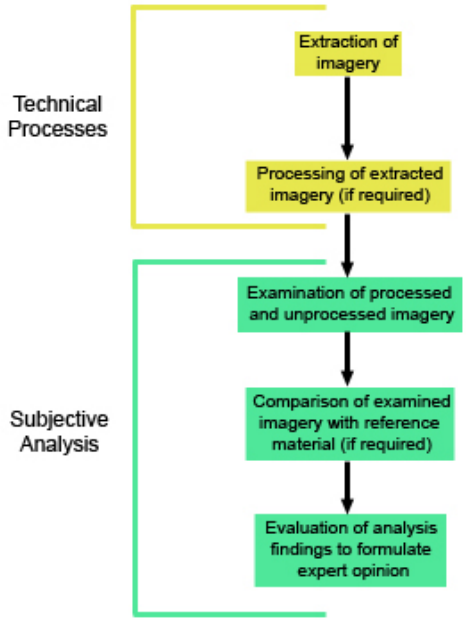

Figure 1 - A basic image interpretation workflow

3.3. Technical Processes

All technical processes, whereby images are extracted and the copies processed (e.g. brightness and contrast adjustments, sharpening), must be documented in detailed contemporaneous notes, which may be disclosed in court. These notes should include details of any hardware or software used to process the images and the parameters applied during the process. The expert must make clear what impact any technical processes may have upon the quality of the imagery and what implications this may have on the subjective analysis. All technical processes should be validated to ensure they are fit for purpose and repeatable.

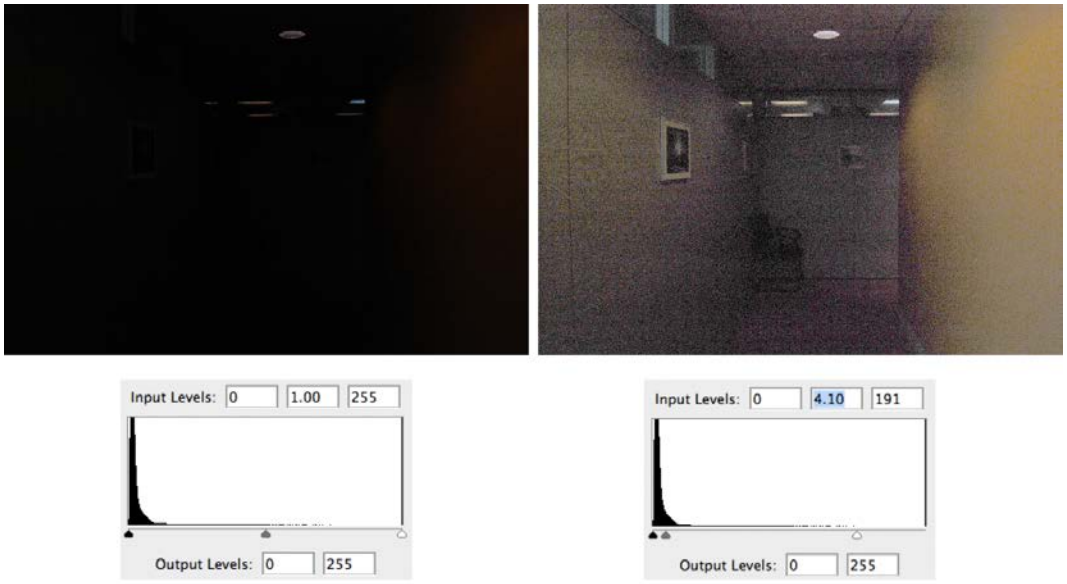

Figure 2 - The image on the right has been brightened using a level adjustment. The histograms show the parameters of the applied level adjustment. Note that although the enhancement has revealed additional detail in the image it has also revealed artefacts in the form of grainy sensor noise.

3.4. Subjective Analysis

Due to the absence of a suitable database of facial features and no universally accepted methodology as to how two facial images should be compared, the analysis aspect of facial image comparison (and many other image interpretation tasks such as vehicle identification and gait comparison) is considered a **subjective** process. Therefore the opinion given by the expert will be based upon their competency, training and study of the specialist subject, rather than objective measurements. The subjective analysis must also be documented in detailed contemporaneous notes. Due to its subjective nature, the quality and reliability of image interpretation evidence can be difficult to determine. It is the experts' responsibility to demonstrate that the subjective analysis has followed a structured methodology, which has been tried and tested using known material, and that all opinions are unbiased and supported by the observations made in the analysis.

When comparing the two images, the expert will examine the questioned imagery in isolation first to determine the level of detail in the imagery, the presence of imaging artefacts and what features are visible. The expert will then compare these observations to reference material to determine the degree of similarity or dissimilarity in the observed features. In the absence of any population data the weight the expert applies to the derived opinion of whether or not the images show the same subject will be decided by multiple factors taken into account during the analysis, such as the quantity and type of features observed. If only

basic class characteristics are observed (e.g. the shape of general facial features such as the nose or mouth in the case of facial comparison) the expert may only be able to assign a low weight to their opinion as such features may be common within the relevant population. If individualising features such as scars, marks, moles or blemishes are observed the expert may be able to assign a higher weight to their opinion, taking into account the context and creation dates of the imagery and the permanence of the features observed. The expert's opinion should be independently verified and/or peer-reviewed by another suitably qualified expert.

Image comparison can provide compelling evidence in the courtroom however, as with all imagery interpretation tasks, the strength of the comparison is at least partially dependant upon the quality of the imagery being compared. If the video or image is of insufficient quality it may be unsuitable for comparison regardless of the knowledge and experience of the expert or the comparison methodology used.

4. Facial Image Comparison

4.1. Facial Image Comparison in the UK

Facial image comparison (colloquially known as “facial mapping”) is a general term used to describe the process of comparing the facial image of an unknown subject to that of a known subject, in an attempt to determine the degree of similarity/dissimilarity between the two subjects. This is not to be confused with facial recognition, which is matching a questioned face to a database of known faces either via computer software or by a human recognising someone they already know. Facial image comparison is perhaps the most commonly used method for identification of a disputed subject from imagery and has been utilised as expert evidence in UK courts for almost 20 years, the first reported case being *R v Stockwell* in 1993. Facial image comparison’s status as an area of expertise is further supported by the *Attorney General’s Reference No.2 of 2002 [2002] EWCA 2373*:

“A suitably qualified expert with facial mapping skills can give opinion evidence of identification based on a comparison between images from the scene, (whether expertly enhanced or not and a reasonably contemporary photograph of the defendant, provided the images and the photograph are available for the jury (R v Stockwell 97 Cr App R 260, R v Clarke [1995] 2 Cr App R 425 and R v Hookway [1999] Crim LR 750)”

The growing use of facial image comparison as expert evidence has lead to it being considered as a forensic discipline in a similar manner to DNA profiling and fingerprint comparison. However, due to the relatively recent emergence of facial image comparison in the court room, the application of the techniques and processes employed by experts in a forensic context is still fairly novel .There has been very limited scientific investigation into whether or not forensic facial image comparison is a reliable form of identification evidence. This is also true of other areas of video and image interpretation, such as colour determination, vehicle identification and clothing and object comparison.

4.2. Factors Affecting Facial Image Comparison

The identification of an unknown individual from imagery, such as CCTV, is a complex task. The identification can be impacted upon by numerous factors, which may limit the suitability of an image for comparison, such as:

- Low resolution (the number of pixels that make up the subject’s face)
- Poor lighting leading to under or over exposure of the face
- Compression whereby the recording device removes fine feature detail in order to save recording space

- Non-matching camera angle (typically CCTV is captured from an elevated angle whereas custody mug shot images used as reference material in facial image comparison are captured perpendicular to the face)
- The subject's features are not distinctive in the population. Lack of knowledge of the prevalence of a set of observed features in the general population may lead to "identification" due to similarity.

The interaction of these various factors on facial appearance may cause two images of different people to become indistinguishable or introduce differences in appearance between different imagery of the same person.

R v Hookway [1999] Crim. LR 750 is the first reported case whereby the defendant was convicted solely on the basis of facial image comparison evidence. However due to the current lack of scientific validation of facial image comparison it is strongly advised that any facial image comparison evidence based upon poor quality video or images (such as CCTV) should be used as supporting evidence only.

5. Assessing Imagery and Commissioning Experts

5.1. Image Quality Issues

When requesting image interpretation evidence the investigator should ensure firstly that the imagery has been assessed by a competent forensic image analyst and is suitable for such analysis and secondly the expert being commissioned is going to produce an output which meets the legal and quality requirements of the CJS.

As stated in section 3, image quality is integral to the reliability of any image interpretation task. Prior to requesting image interpretation or comparison evidence, a basic assessment of image quality is advised to determine if the video or image under consideration is of sufficient quality for meaningful and reliable analysis. The following points provide a basic guide on image quality issues, however, the assessment of image quality should be performed by a competent forensic image analyst. The following figures (Figure 3 to Figure 7) are not necessarily unsuitable for image comparison or interpretation but highlight certain issues that may limit the suitability of an image for comparison.

5.1.1. Resolution of the subject/distance from camera

A digital image is made up of a finite number of pixels - this is the resolution of the image. Pixels are the smallest component of an image, therefore the greater the number of pixels in an image the higher the level of detail that can be discerned. If the subject to be identified is a substantial distance from the camera or only occupies a small proportion of the image, then the number of pixels that make up the subject may be low. As a result, the level of detail will be very limited and may not be suitable for reliable interpretation. Enlarging an image beyond its resolution will **not** add additional detail, but will only duplicate existing pixels resulting in a blocky or blurry appearance, depending upon the method of enlargement. The potential for enhancement of low resolution imagery is generally very limited.

Figure 3 shows a still image taken from a CCTV recording. The subject's face has been enlarged within the frame. Note the lack of fine detail within the enlargement and only the presence of general class characteristics such as the nose and mouth, which are represented in poor detail.

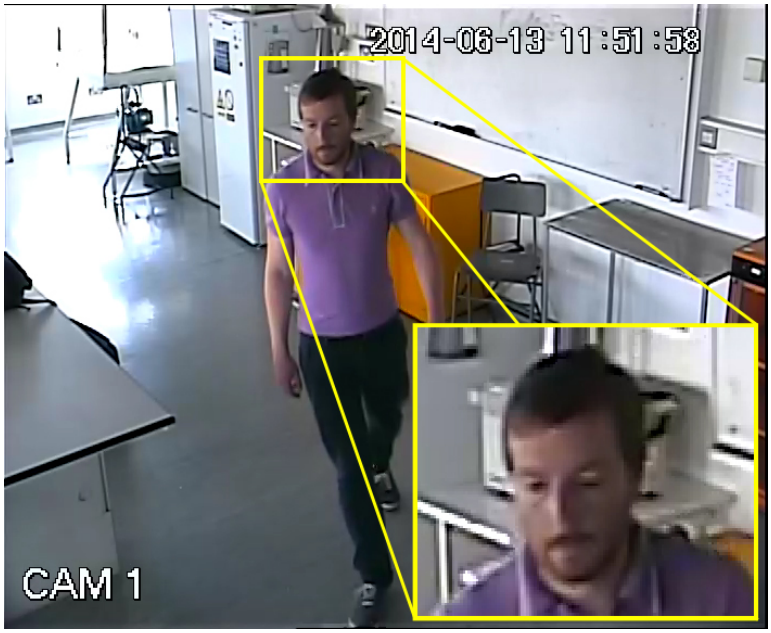

Figure 3 - The subject's face occupies a small proportion of the overall image, limiting the resolution of the face. Enlarging the image does not add any extra detail.

Figure 4 shows an example of a number plate recorded approximately 7 metres from the camera (the image is cropped). Figure 5 shows the same number plate in sufficient detail that the characters can be read clearly. Note that in Figure 4 the certain characters have been distorted to such an extent that they could be mistaken for different characters. The enhancement of low quality imagery, whilst possible, should be interpreted with caution.

Figure 4 – Cropped image of a number plate recorded using a common CCTV system approximately 7 metres from the camera with Motion JPEG image compression

Figure 5 – The same number plate imaged using a high resolution stills camera

5.1.2. Brightness

If the ambient lighting of a scene is too bright or too dark and if the parameters of a camera are not set to accommodate this then an image maybe overexposed (too bright) or underexposed (too dark). In some instances it may be possible to adjust the brightness of an image to reveal detail. If the exposure of the image is too extreme then any detail in that area of the image may be lost and unrecoverable.

Figure 6 - The image on the left hand side is over exposed causing parts of the image to become white, so that the detail in these areas is lost. The image on the right hand side is underexposed, adjusting the brightness of the image has helped but some detail has been lost

5.1.3. Compression

In order to maximise the use of storage space on a device it is commonplace for video and images to be compressed to reduce file sizes. If the video or image is heavily compressed this will result in a loss of detail that cannot be recovered and will introduce visible artefacts into the image. Heavily compressed imagery lacks fine detail and is generally limited for most image comparison and interpretation tasks.

Figure 7 - The right hand side image has been compressed as a low quality JPEG image resulting in a loss of detail, this is apparent in the facial features of the subject and the brickwork of the surrounding scene.

5.1.4. Camera angle

The rotation of a person or object and the angle of the camera have a significant effect upon its appearance. Ensuring that reference material is captured at a matching angle to the questioned video may help to improve the reliability of the comparison.

5.1.5. Number of visible features

Image comparison relies upon the expert being able to observe multiple features of the disputed subject in sufficient detail that they can be meaningfully be compared to the images of the known subject. For example, in facial image comparison if the face of a disputed individual is obscured in the image and only a limited number of features are visible, then the potential for reliable identification maybe greatly reduced.

Each of these factors will impact upon the suitability of a video or image for interpretation and comparison. Often there may be multiple quality issues with an image (e.g. low lighting, compression and distance from camera) and the combination of these issues will be further detrimental to comparison suitability.

5.2. Commissioning Reliable Experts

At the level of general principle, reliability can be demonstrated if the following requirements are met. In each case the relevant parts of the Criminal Practice Directions (CPD) 19A (governing the reliability of expert opinion, especially expert scientific opinion) are noted.

- The analysis of images, and the content of images, can involve a number of different processes. There is no requirement that all of these processes or techniques are applied by the same person in any given case. The person instructed to perform any given process/technique must have appropriate expertise in the work performed. [CPD 19A.5.e].
- The expert must understand and comply with the duty to provide impartial and unbiased assistance to the court.
- The methods employed must be properly documented and the work subject to a suitable quality management system. This must include adherence to the Forensic Science Regulator's Codes of Conduct and Practice.
- The methods employed must be properly validated. The approach to validation is set out in the Regulator's Codes and associated guidance. The validation should have particular regard to the following issues:
    - That the methods employed are based on sound science and, where relevant, employed within limits which maintain the reliability of the results obtained. [CPD 19A.5.a, 19A.6.a, and 19A.6.d]

- The degree of acceptance of the methods, and their use in the relevant field of forensic science, in the scientific community. [CPD 19A.5.d and 19A.6.a]
- Whether the approach adopted has diverged from common practice in the area and whether such divergence can be justified. [CPD 19A.5.h]
- That the methods are supported by a sufficient body of robust data to demonstrate the reliability of the results obtained [CPD 19A.6.c]
- That the method employs a scientifically/statistically valid interpretation model which is used within the limits of its applicability. [CPD 19A.5.c, 19A.6.a and 19A.6.b]
- That the interpretation method is supported by a sufficient body of robust data to ensure the reliability of any interpretation or conclusions drawn. [CPD 19A.6.c and 19A.6.e]
- That any conclusions drawn take due account of the uncertainty of measurement etc. of the methods and interpretation model employed. [CPD 19A.5.c]

- The processes adopted must have sufficient safeguards to prevent the expert's analysis being improperly influenced by information about the case. This is commonly referred to as contextual bias whereby the provision of unnecessary contextual information to the expert (consciously or unconsciously) influences his opinion. As such, experts should only be provided with information that is relevant to what they are being asked to interpret and it should not be presented in such a way as to invite them to confirm an as yet unproved proposition. The guidance document 'Cognitive Bias Effects Relevant to Forensic Science Examinations' [FSR-G-217] published by the Regulator addresses the management of case and context information and bias mitigation by forensic experts during examinations.
- In reaching an evaluative opinion on the likelihood of an image matching the reference image, experts should stress that their opinion is subjective and ensure that in reaching a conclusion they have regard to the decision of the Court of Appeal in *R v Atkins and Atkins [2009] EWCA Crim. 1876*, in which it was stated that an expert could express his conclusions as to the significance of his findings by using a verbal scale. The expert should consider two or more competing propositions when presenting his conclusions to demonstrate that the findings are not biased towards a single hypothesis. Opinions should not be expressed by reference to statistical probabilities in the absence of any statistical database recording the incidence of the features compared as they appear in the general population.
- The report/statement must comply with the provisions of the Criminal Procedure Rules (particularly Part 19) and the Criminal Practice Directions. The report/statement must be subject to an independent review, by a suitably qualified expert, before being issued.

6. Points to Note for Investigators

In addition to the requirements detailed in Section 5, the checklist below provides points to consider for investigators wishing to commission facial image comparison and related image interpretation evidence.

- Due to the unknown reliability of image interpretation and facial image comparison it should not be used as primary evidence for positive identification if the video or images to be compared are of low quality. Consider what other evidence is available in the case before requesting facial image comparison or image interpretation.
- Original video and images should always be used for comparison/interpretation if available. If the material has been edited or converted in anyway this may lead to a loss in image quality.
- Image quality is integral to all image interpretation tasks. If poor quality imagery is used results may be too limited to aid the court or may even be unreliable.
- Reference imagery should be captured from as many different angles as possible, including the angle of the questioned video. Reference images should ideally be captured as close as possible to the date of the questioned footage. For facial image comparison a reconstruction in addition to high quality reference imagery may be beneficial, whereby the known individual is recorded on the same device as the questioned imagery and under similar lighting conditions, in order to provide like-for-like reference material.
- Instructions to an expert should be clear, concise and free from biasing information. The initial instructions form the basis of the expert's subsequent work. Any instructions and prior information supplied by the investigator must be stated in the expert's report.
- When requesting comparison/interpretation evidence the expert should only be aware of case details that are relevant to the comparison i.e. the timings and camera numbers of when the subject is on screen and the dates images were captured. Providing the context of a case may bias the expert towards a particular conclusion and once bias has been introduced it cannot be removed. As a rule of thumb the expert should be provided with the minimum amount of information to carry out the comparison as more detail can be revealed if requested by the expert. Think carefully on how a question or request is phrased before sending it to an expert, for example the following questions could bias an experts examination:

"Is the vehicle shown in the CCTV a silver Volkswagen Golf?"

or

"Is the suspect in the CCTV holding a knife?"

Instead rephrase to questions as follows, to minimise the risk of bias:

"What is make and model of the car shown in the CCTV?"

or

"Is the subject in the CCTV holding an object? Is it possible to determine what this object is?"

- The National Crime Agency Specialist Operations Centre (SOC) holds the Expert Advisers Database, which contains details of current forensic experts whose evidence has previously been accepted by the Courts. The SOC can also provide additional guidance on the management of experts, including establishing terms of reference with experts. The SOC can be contacted on 0845 000 5463.

7. Points to Note for Prosecutors

The checklist below provides points to consider for prosecutors in deciding whether to call image comparison evidence and in challenging defence experts. It should be considered in conjunction with the overarching Legal Guidance on Experts, available at the attached link:

http://www.cps.gov.uk/legal/assets/uploads/files/expert_evidence_first_edition_2014.pdf

- Is expert evidence actually required? If the disputed imagery when compared with the reference imagery is sufficiently clear so as to enable a bench of Magistrates or a jury to reach its own conclusions as to the similarities between the images, then there is no need to obtain expert evidence to assist.
- Is the proposed expert actually an expert in type of material being compared in an image? An expert in CCTV or video enhancement will not generally be qualified to give an opinion on facial comparison, human anatomy or vehicle comparison. Particular caution is required with those who purport to identify (as opposed to compare) objects from CCTV. What qualifications do they have, for example in vehicles that allow them to identify a certain make and model of vehicle with certainty?
- Does the method employed have a scientific basis or form part of a recognised body of knowledge?
- What protections were in place to avoid contextual bias? – Was the expert provided with information that might have lead him to reach a particular conclusion? For example, he might be provided with a reference photograph that he is told was taken on arrest or he might even be asked to confirm that the male in the reference photograph is the male that the police suspect is the offender in the CCTV.
- What quality standards are employed by the person/organisation?
- Has the report been peer reviewed prior to submission?
- Has Rule 19 of the Criminal Procedure Rules been complied with?
- Have the indicators of reliability in CPD Part 19A (above) been addressed?
- Crucially, what evidential value can actually be placed on the results? For example, the mere fact that the subject in a reference image is wearing similar clothing as the subject in the disputed image is irrelevant if there has been some delay between the capturing of the two images and the subject in the reference does not accept that he has not changed his clothing.