Executive Summary

1. This submission is intended to provide a brief highlight of the following points:
   1.1. The extent of imagery evidence used within the UK judicial system.
   1.2. The need for education throughout the judiciary and regulatory bodies.
   1.3. The fact of Imagery Analysis as a distinct career field.
   1.4. A brief history of Imagery Analysis.
   1.5. The science that underpins Imagery Analysis.

Introduction

2. This document is submitted on behalf of Eurofins Forensic Services. Whilst the points raised are based on the experience of the Eurofins forensic imagery team as a whole, I have included particular references to my own personal experiences drawn from over three decades of work within the field of Imagery Analysis. I served a 23 year military intelligence career as a Royal Air Force Imagery Analyst. During this time, in addition to various operational tours of duty in the Middle East and Northern Ireland, I was fortunate to serve two tours of duty as an instructor at the UK’s school of imagery analysis. On retiring from military service in 2010, I made the transition to the forensic application of imagery analysis and have provided expert evidence to both the prosecution and defence. As an Imagery Analysis Expert Witness I have given evidence at the Central Criminal Court, various Crown Courts across the country and I was also engaged as an imagery analysis expert witness for the Al Sweady Inquiry. In 2017 Eurofins acquired the entire forensic and security division of LGC Ltd and Eurofins Forensic Services is now one of the world’s largest private forensic service providers. This submission is made in order to highlight the significant concerns that this team have in relation to the use of imagery evidence throughout the UK judicial system.

3. Imagery evidence is an ever increasing aspect of our judicial system as more and more sources of imagery become available. In addition to the dense and widespread coverage of CCTV systems throughout the UK, other devices such as mobile phone cameras, dash cams and body worn cameras are now common sources of imagery evidence.

4. Society in general is now very familiar with recorded images, whether that may be from television, advertising or social media. But that familiarity presents a danger when imagery is submitted as evidence in Court as it can, and does, lead to the mistaken belief that anyone is capable of accurately interpreting an image.
5. Forensic Imagery analysis is a very small specialism within an overall small career field that includes a number of diverse applications. The world of imagery analysis is very much dominated by its application in the military intelligence field, but, by its very nature, the techniques and capabilities of imagery intelligence analysis are not made known to the general public. In this respect there is a general lack of awareness that imagery analysis exists as a distinct career field and also a lack of understanding as to why it is necessary for imagery evidence to be considered by a properly trained and experienced analyst.

6. The challenge that faces the UK’s forensic imagery analysis community is one of education. Police officers, solicitors, barristers and judges require a much better understanding of the complexities of imagery evidence and how it can be properly applied to the judicial system. Furthermore, it has to be said that this need for education also extends to those in other forensic disciplines and, most importantly, to the current regulatory bodies.

**History**

7. Whilst the advent of digital imagery is a relatively new technology within the judicial system, imagery analysis is not a new career field. The First World War necessitated a rapid growth in the use of aerial imagery and one of the pioneering Photographic Interpreters [PI] was Captain Hugh Hamshaw Thomas of the Royal Flying Corps. In civilian life Hamshaw Thomas was a Fellow of Cambridge University and a world renowned figure in the field of paleobotany, but in 1918 his military service lead him to write one of the first manuals of Photographic Interpretation. Some of the fundamental imagery analysis principles established by Hamshaw Thomas a century ago apply equally today in the digital world as they did to the battlefields of the Great War.

8. During the Second World War Hamshaw Thomas served as a Royal Air Force Wing Commander and played a pivotal role in the success of the allied aerial reconnaissance operations. Winston Churchill’s daughter, Sarah Oliver, also served alongside Hamshaw Thomas as a PI and as a result her unit would be subjected to regular impromptu visits by the Prime Minister who took a keen interest in the various aspects of analysis being carried out.

9. In more recent times, the imagery analysis field has adapted to new technologies such as traditional wet film being replaced by digital systems, earth observation satellites providing more and more data at increasingly better resolution and, with specific relevance to the legal system, the rapid growth of CCTV systems.

10. Over the past century the UK has played a key role in the development of imagery analysis and students from around the world have turned to the UK for training in the science and techniques associated with this discipline. Although restricted to military and Civil Service personnel, for decades the UK has operated a school of imagery analysis. The Joint School of Photographic Interpretation [JSPI] was formerly based at Royal Air Force Wyton in Cambridgeshire before relocating to the Defence Intelligence and Security
Centre, Chicksands in Bedfordshire where it now exists as the Imagery Intelligence Training Wing.

**The Science of Imagery Analysis**

11. It is crucial to understand that any recorded image, whether it is derived from a satellite, a mobile phone or a CCTV camera, is simply the best attempt by that device to record a three dimensional world in a two dimensional form. In this respect the old adage of "a camera never lies" needs to be treated with caution. A common misconception is that an image will always represent an accurate and reliable record of the scene. It is fundamentally important for the judicial system to understand that this is simply not the case and that the accuracy and reliability of any recorded image can be influenced by a vast and complex array of factors. It is the role of the trained and experienced imagery analyst to consider all of the potential factors that affect the reliability of an image as this will form the basis of any analysis.

12. *The Electromagnetic Spectrum* – A fundamental aspect of imagery analysis training is to study how the various bands and wavelengths of electromagnetic [EM] energy can be employed to provide a recorded image. At one end of the spectrum are the shorter wavelengths of energy, such as X-rays, and we are familiar with the concept that these images require the attention of qualified radiologists and doctors to accurately interpret this type of data. As wavelengths become longer, the spectrum includes the ultraviolet band and then the wavelengths that the human eye is responsive to, the optical, or visible, band. The visible part of the spectrum is a narrow band that extends between 0.4 and 0.7 microns and includes the wavelengths that correspond to all the colours of the rainbow familiar to the human eye. In good lighting conditions a CCTV camera will operate within the visible spectrum and record conventional colour video imagery. However, in low light conditions there is insufficient visible energy and therefore most CCTV cameras will resort to recording a form of energy that the human eye cannot perceive, near infrared [Near IR]. Accurate analysis of Near IR imagery requires the analyst to be aware of the way in which different materials behave in these conditions and it is important to understand that, in particular, the tonal presentation of objects can be very different to that seen in optical conditions. The imagery analysis rule book then changes again as the spectrum transitions into the Thermal Infrared [TI] band. TI imagery is largely concerned with emitted rather than reflected energy and although these sensors are often referred to as *heat detecting cameras*, an imagery analyst needs to understand that that description is not accurate and there are a complex number of factors that determine how a TI image is formed. Finally, the spectrum moves into the microwave wavelengths which are utilised in RADAR imagery. This is a particularly challenging form of imagery that again requires a very different rule book for the analyst.

13. *Computer Science* – One of the most complex aspects of imagery evidence today is the digital nature of this evidence. The vast array of different CCTV system manufacturers is such that imagery can originate from cameras and recording devices that each have their own particular digital characteristics and their own proprietary recording formats. The way in which an image is
formed and recorded has huge implications for the accuracy and reliability of that image and every analyst has to be aware of the potential pitfalls. As well as understanding the basic digital structure of an image, an analyst needs a comprehensive understanding of various digital aspects such as file formats, compression algorithms and interpolation algorithms, all of which have significant influence on the interpretability of an image.

14. Imagery Analysis Considerations – During the initial phase of any imagery analysis task it is necessary to interrogate the media and establish the limitations of the imagery evidence. This initial assessment of the imagery data will include such considerations as:

14.1.1. Resolution – the smallest component of a digital image is a Picture Element, or Pixel. Each pixel can only represent a single tone or colour. Pixel resolution is determined by the number of available pixels within a frame of imagery.

14.1.2. Aspect ratio - describes the proportional relationship between the width and the height of an image and is commonly expressed as a ratio i.e 16:9. The aspect ratio of a recording can often be incorrect and require adjustment to ensure that objects are presented with accurate proportions.

14.1.3. Frame rate – Video imagery is a sequence of image frames. Frame rate (expressed in frames per second or fps) is the frequency (rate) at which consecutive images are displayed. To create the illusion of natural fluid motion, a frame rate of 25 fps is required. However, many CCTV systems record at considerably slower frame rates which necessarily limits the ability to accurately determine the nature of fast dynamic activity.

14.1.4. Lighting Conditions – The extent and the nature of the ambient lighting conditions will significantly affect the resultant imagery. Artificial lighting can include tungsten, fluorescent, LED and sodium lighting sources each of which can affect the tonal/colour presentation of an object.

14.1.5. Sensor Type – As previously described, depending on whether the imagery is optical, near infrared or thermal infrared there are specific imagery analysis characteristics and behaviours that have to be understood.

14.1.6. Compression – CCTV systems are required to operate 24 hours a day, seven days a week and therefore each system generates a considerable amount of image data. In order to reduce the amount of computer storage required, various forms of compression can be applied to the recording. Spatial (or intraframe) compression is applied to each individual frame of the video, compressing the pixel information as though it were a still image. Temporal (or interframe) compression is applied over a series of frames and takes advantage of areas of the image that remain unchanged from frame to frame, discarding data for repeated pixels. When determining the accuracy and reliability of any image sequence it is vital to understand the form and extent of the compression employed by the recording system in question.
14.1.7. Subject-to-Camera Range/Angle – The distance between the camera and the area of interest has a significant effect on the level of presented detail. The further an object is away from the camera the smaller in scale it will be. The angle of view can also influence the interpretability of the image. This leads to a common imagery characteristic known as foreshortening, meaning that an object’s dimensions along the line of sight appear shorter than its dimensions across the line of sight.

14.1.8. Motion Blur – Movement of an object during the recording of a frame of imagery can result in a distinct blurred effect.

14.1.9. Lens Distortion – depending on the type of lens employed on the camera system, linear objects can appear to be curved. Image processing may be required to correct such distortion.

14.1.10. Colour rendition – Determination of colour from recorded imagery is problematic. For this reason an imagery analyst will generally refer to an object as being light toned, mid toned or dark toned. The presentation of colour can be dependent on a variety of factors including the colour calibration of the camera, the type and degree of compression applied to the recording and the ambient lighting. If, for example, lighting conditions are on the cusp of the optical and near IR bands then the presentation of colour can be distorted by elements of near IR energy in the recording.

14.1.11. Level of Presented Detail – Resolution and compression have a significant influence on the level of fine feature detail presented in an image. It is important to note that if a feature cannot be observed within an image it does not follow that that feature was not present at the time of recording. It may just be the case that the recording system is simply not capable of resolving that level of small detail.

**Expert Evidence**

15. The general lack of awareness throughout the judiciary as to the nature of imagery analysis presents a real and significant weakness in the use of imagery evidence in Court proceedings. In the course of my forensic work I am regularly faced with examples of non-imagery experts who make fundamental errors in their own assessment of imagery data. In order to illustrate this serious problem it is necessary for me to refer to a case in which I was instructed by the Defence. Although I was initially instructed to conduct a facial comparison analysis, Defence Counsel made me aware that the Crown had engaged the services of an expert from the sports clothing company Adidas in relation to the footwear worn by the offender. The footwear expert had been invited to review the CCTV evidence and comment on whether the shoes worn by the offender were of a particular design. The footwear expert stated in evidence that he could identify the particular shoes worn by the offender due to a number of design features. Having reviewed the imagery evidence in question, it was clear to me as an imagery expert that the CCTV data was simply not capable of reliably presenting the detail that the footwear expert claimed to have identified. The Judge in this particular case agreed that whilst the gentleman from Adidas was eminently
qualified to give expert opinion on the subject of Adidas shoes, he was not qualified to give expert opinion on imagery evidence. It is my belief that this is not an isolated example and, given the extent of imagery evidence that features in criminal cases, I have significant concerns as to the amount of that evidence that is being used in Court by unqualified experts on a daily basis.

16. One of the most concerning aspects of the way in which imagery evidence is considered within the legal framework is the misguided belief that in order to compare two objects it is necessary to be an expert in that particular object. This is fundamentally wrong. If the evidence submitted to a Court is that of recorded imagery then first and foremost, regardless of whether the object in question is a face, a vehicle or a jacket, it is imperative that the Court is assisted by a properly trained and experienced expert in the field of imagery analysis. This ensures that the Court understands not only what can be reliably said about the evidence but also what cannot be said. Depending on the nature of the object in question and the particular matter that needs to be addressed, there may be a requirement for particular subject matter expertise but it is imperative that this is considered as an additional level of expert comment over and above that given by the imagery expert. For example, the Eurofins Forensic Imagery team is regularly instructed to conduct comparison analysis of firearms. This will typically involve the analysis of recorded imagery of a weapon used in an offence versus images of a recovered device. Following the completion of the analysis, the imagery analysis report is then forwarded to our forensic firearms colleagues in order for them to conduct their own peer review as firearms experts. This approach ensures that the authenticity of the imagery evidence is properly addressed as well as ensuring that the subject matter specific aspects of the analysis have also been considered.

**Summation**

17. Imagery evidence is a regular feature of 21st Century criminal proceedings and the availability of this evidence will only grow as new imaging technology emerges. However, it is evident that the UK judicial system is unaware as to the complexity of this evidence type and is also unaware as to the vital need for this data to be considered by properly trained and experienced imagery analysts.

18. Education is necessary throughout the judicial system to ensure that imagery evidence is treated with the same respect as other forms of evidence. Poor working practices and a lack of training and awareness can result in vital evidence being lost. Whilst it would be unthinkable to suggest that a Police Community Support Officer [PCSO] would be tasked with the recovery of DNA samples from a crime scene, it is not unusual to discover that untrained personnel have been tasked with the recovery and handling of image data.

19. The current programme of regulation within the forensic science sector is welcomed and will undoubtedly help to improve the standard of working practices. However, in order to regulate a particular forensic discipline it follows that the regulatory bodies themselves should have some concept of that particular discipline. Currently it would seem that an organisation can
achieve accreditation if its working practices satisfy the criteria laid down by UKAS even if those working practices do not represent best practice. This situation can only serve to undermine the authority of the UK’s regulatory bodies.

20. Imagery analysis is a distinct career field. It is complex, challenging and requires a combination of natural aptitude, thorough training and, most importantly, experience. If imagery evidence is submitted to our Courts without recourse to a properly trained and experienced imagery analyst, the potential for miscarriages of justice is real and significant and this threat needs to be recognised and addressed by both the judiciary and the regulatory bodies.

13 September 2018