

Multispectral imaging

[Law](#), [Crime](#)



Multispectral imaging is used over an extremely wide spectral domain. It started with NASA using the technique for satellite imaging using kilometer-length radio waves, to the technique being used by forensic science using light in the visible to the near infrared region, to medical forensics using MeV gamma rays (National Research Council 1998) The use of Multispectral imaging in forensics and law enforcement for the examination of a wide variety of evidences is a field that is growing but has not yet reached the state of being a universally accepted practice.

The technique is being used for analyzing photographic and video based evidence, and also for DNA analysis in recent times (Lanir 2005) Using Multispectral imaging has both advantages as well as certain disadvantages in the analysis of a scene. In addition, there are some pre-requisites needed which make the approach limited to certain situations. All these points are discussed subsequently in this section. Advantages of Multispectral Imaging Technique 1.

Advantage over naked-eye viewing – While a human eye has the capability of differentiating between millions of colors and various combinations; it is obvious that the perception is usually dependant on a mixture of different wavelength. In other words, the complete spectral information as received by eyes is still incomplete. The reason for this is because the visible portion of light, no matter the degree of its complexity, is still divided into the three basic colors – red, green and blue. Multispectral imaging can generate the accurate and complete optical spectra at every pixel.

Finally and image processing software can be used for getting the maximum information from each of the pixels (Condea , Haneishia, Yamaguchia , <https://assignbuster.com/multispectral-imaging/>

Ohyama & Baaz J 2007) This might not be very important and might seem like overkill for regular vision. But in case of forensics, where the actual and precise data is necessary, this capability becomes very helpful as the data is completely analyzed. Differences in spectra can be used for the accurate detection of foreign particles in a terrain or differences in finger prints from different individuals .

Advantage over cameras – Forensic science is the capture and preservation of accurate image. Conventional color films and digital color cameras also break the various colors combinations in RGB, so the information is just as inaccurate as seen with a naked eye. Hence, multispectral imaging scores over using these equipments also (Chieu 2001) In addition, multispectral imaging can be used in areas which are inaccessible and can give simple multi-temporal readings. The area range of the scene is also more than what is for a digital camera.

Also, until very recently the use of numerical processing was fairly restricted in the camera systems. Finally, Multispectral imaging also offers light attenuation techniques (Westland & Ripamonti 2004) 3. Avoid Contamination of the crime scene – One of the advantages provided by using multispectral imaging is that there is no need for constant physical contact with the crime scene. This characteristic helps in two types of investigations. In case of analyzing a crime scene for evidence, the constant contact means contamination which can be avoided because the multispectral imaging can be taken aurally.

This feature is also used in the forensic analysis of ancient documents where the contact with the document should be minimal. In such cases the

document can be reconstructed with minimum contact. The aerial image taking capability also helps in dangerous locations also, as in the case of finding the location of a minefield. The initial identification of a minefield helps in localizing the area using an airborne multi-band camera. Using light in both the visible and infrared region minefield having both surface mines and well as buried mines can be detected (Sjokvist Lundberg Gu & Ulvko n. .)

4. Time and Cost Saving – Using multispectral imaging the complete analysis can be done faster than using conventional methods and also cost for producing the same results using the other spectroscopic methods is much costlier. This is because, the wide range of operation of multispectral technique i. e. from ultraviolet to visible to thermal infra red, means that many different physical parameters can be analyzed simultaneously. Also the data has no major spatial co-registration problems.

As an example in case of medical diagnostics and forensics, the interface used for multispectral imaging is easy to use and also much cheaper than conventional systems like the 7T MR scanner. Disadvantages of Multispectral Imaging technique Multispectral imaging is not without its faults. Some of them are primarily due to the budget and requirement of the individual area where multispectral imaging is used. 1. Complete Image not provided – Multispectral imaging does not provide complete 3D image. The reason is that this technique does not offer any method to separate the effect of absorption from scatter

Spatial resolution - Multispectral imaging due to its optical nature does not provide for complete spatial resolution. Some ways that have been

suggested is to examine by contrasting with IR image but with acoustic resolution. In the case of detection of landmines, the problem is that while the technique can judge the presence or absence of mine over an area, the exact location cannot be pinpointed. This means that the technique can be just used to find if the area is contaminated by mines, but the detected rate of each single mine is not high (Sjokvist Lundberg Gu & Ulvko n. d.)

System Complexity – Analysis of complex systems poses a problem when multispectral imaging is used. This tendency increases as the system complexity increases. For example , in case of mine detection, the mine field is assumed to have a near perfect alignment which is not always possible in case of real time environments (Sjokvist Lundberg Gu & Ulvko n. d.)

2. Noise Vulnerability – This is one of the critical requirements of any forensic detection techniques. Multispectral image by its very nature are sensitive to any pollutants, which is why the crime scene has to be assumed to be clean from any external influences.

The spectral features of any foreign body is more important than its chemical or biological properties, which raises the probability of mistakes as all environmental substances have broad spectral absorbance bands (Miskelly & Wagner 2005)

3. Complexity of analysis - A crime scene can be considered to have a limited number of objects having distinct spectral characteristics. Some experts feel that most of the individual scene should hence be individually analyzed for an accurate reproduction.

This means that each scene would have different multispectral properties which would mean a different system, making the detection complex. In addition, this also calls for advanced digital signal processing techniques and

the possibility of large quantities of data to be analyzed (Gordon 2001) 4. Usage in Crime Scene – While multispectral imaging is increasingly being used to analyze physical evidence, the first hand usage in crime scenes is not very popular even now. This is because the technique is much too costly for usage for normal forensic departments.

In addition, the equipments are not portable enough for it to be easily taken to a crime scene (Gordon 2001) 5. Image recreation – This problem occurs at the time of image recreation. However, not every field faces this problem. In case of document forensics, where the final document has to be reconstructed, specialists observe the complete image before deciding on the parts to include. The image recreation needs human presence however. However, in case of some other forensic scene recreation, the problem might become more difficult.

This is because, the image given by a multispectral analysis is 3D in nature, though not complete. But the image presented or used by an observer is 2D. Hence, the transformation of the image and the components to select the exact transformation is not very easy (MacDonald & Luo 2002) Limitations of Multispectral Imaging Technique Multispectral image techniques need some additional technology boost before they can be successfully used for forensic applications universally. 1. Problems in analyzing details – As has been said earlier, multispectral imaging was used by satellites for recording data.

From this distance, any blurring is attributed to distance and smaller details were usually not expected. When the technique was applied for analyzing objects at smaller distances, like forensic analysis of document, initially the results were satisfactory. This means that the results obtained were much

better than was observed using the optical techniques employing the RGB technique. However, the problem arose when the details in the document were not very clear. (Hill 2005). The image size is also not that of the original image which also makes the alignment difficult.

Also the many imperfections which are inherent of the real world, makes it difficult for the technique to be used in the real-time situation. Here, the contamination is almost entirely expected. The noise is however not acceptable while using the multispectral imaging technique. Researches are on for finding a suitable fusion technique which is both adaptive and intelligent enough to take care of these conditions, though it might take some time for this to actually materialize (Danien & Grant 2006) 2.

Calibration Errors - There is another problem that might happen when multispectral imaging is used for analyzing details at subatomic levels. The problem is related to precision of the technique and occurs due to imperfect calibration of equipments. The errors means false data being sued as input which raises the error when the output data is analyzed. This in turn effects the spatial resolution when a simple approximation is needed for the temporal evolution. There is also a very high requirement for symmetry as the technique is primarily related to pixel information (Koch Haan & Mancini 2004) . Need for reconstruction software - An imaging software package is essential for making the final image which would be analyzed.

The problems lie when this imaging software is not up to the standard. In this case, the entire advantages are in the danger of being lost. Unfortunately, the reconstruction still requires human presence despite the sophisticated software packages available. The output image deciphering from these

software have proved to be confusing, and hence scientists prefer analyzing in the human presence which is a tedious process (Foy & Theiler n. d)

Future Application and Trends in Multispectral imaging With the many advantages that can be achieved using Multispectral imaging techniques, the near future will see more research in this field. Forensics will now be the main focus, as because of the accuracy of data that can be found using this technique. There are however many issues that need immediate attention. The most important is the image retrieval software which is very important for the analysis of the evidence by investigators. The area is seeing lot many advances with many tools being developed that target specific areas of forensic work.

The second target area is the reduction in equipment size and complexity. Use in satellites did not put a lot of restrictions to the size of the equipment. However, when it is used by investigators for crime scene detection, the size of equipment becomes important. The equipment should also be able to access spaces, meaning that it should be able to cover the entire crime scene. The interest in making smaller electronic devices with higher computer power may prove to be very helpful in this case. In addition, the research is also being done to improve the quality of optical systems

Finally, the multispectral imaging technique itself should be improvised such that its susceptibility to noise is reduced. In many cases like landmine detection, a prior analysis of the land is first done before using the multispectral equipment, which is a good solution. Investigators are finding that using multispectral imaging assists in the process of analyzing evidence.

Sufficient research in this field to make the technology more efficient, will help it in becoming a universally accepted technology.