D4 A Hyperspectral Analysis of Fabrics Submerged in the Indian Ocean: An Innovative Way to Aid in the Estimation of the Time Human Remains Have Spent in Water

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Learning Overview: After attending this presentation, attendees will understand the ways in which Hyperspectral Imaging (HSI) may be utilized in an aquatic forensic setting to age different fabrics (cotton, neoprene, satin, and velvet) following submergence in a marine environment for a period of one to six months. The outcome of this research identifies how the reflectance changes through time and with which fabrics this methodology can be successfully applied.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating the potential usage of HSI in aquatic crime scene analysis. Furthermore, this research will contribute toward increasing the number of tools forensic investigators have at their disposal for increasing the accuracy of the minimum Postmortem Submergence Interval (minPMSI) of clothed human remains in a marine environment.

The estimation of the time since death, minimum Postmortem Interval (minPMI), is a crucial aspect of a forensic investigation. In an aquatic environment, this process is particularly challenging due to the complexity of the corpse's decomposition process and the many impacting environmental factors. Furthermore, there is a general paucity of research in this field. Recently, the use of clothing recovered alongside a corpse in aquatic crime scenes has come under focus for their potential in the estimation of the time spent in water. It is likely for clothing to be present and to be colonized by biofouling organisms (e.g., barnacles), which can be used to estimate the time the victim has spent in water. However, thus far, biological/zoological-based estimation methods are the only avenues that have been explored for aging clothing in an underwater context. This research is the first to focus on the use of HSI for aging fabrics, considering the modification of their optical properties as a result of exposure to a marine environment.

This research focused on four common fabrics: cotton, neoprene, velvet, and satin, which were submerged in the Indian Ocean off the coast of Perth, Western Australia, for a period of one to six months. The aims of this research were: (1) to explore and quantify the optical properties of the fabrics by comparing spectral profiles and how they change due to marine exposure; and (2) to determine whether this information can offer support in estimating the minPMSI of clothed human remains recovered from a marine environment. Fabric samples were used to generate spectral profiles for all the submerged fabrics and controls (n=112). Spectral data was collected at 76 wavelengths between 400-1,020nm using GenASIs® Hyperspectral Imaging Instrument and, using the GenASIs® Spectraview® image analysis software, three pixels were selected from each sample for analysis. The analysis focused on comparing the average spectral reflectance within and between the fabric samples at monthly intervals to determine whether a significant change occurred as a result of marine exposure.

Cotton demonstrated the most significant changes as a result of exposure. Physically, the material became highly degraded and, by six months, was structurally compromised. A strong negative regression in the average spectral reflectance was recorded over the six months. There was no significant regression trend identified for satin, neoprene, or velvet. Satin demonstrated notable changes with a significant difference in the average spectral reflectance occurring between the control samples and the submerged samples, but with little differences between the submerged samples. Neoprene demonstrated minimal significant changes, with months one to four showing similar profiles to the controls and some significant differences in months five and six. This result suggests that a more longitudinal study may yield more data from neoprene. Furthermore, neoprene was also the least physically altered fabric out of the four, showing minimal degradation as a result of exposure to the marine environment. Velvet demonstrated no significant change in average spectral reflectance as a result of aquatic exposure. Overall, results show that the HSI approach can be successful when used on cotton and satin in the first months of submergence, while HSI highlights the changes in neoprene after at least four months of submergence. With regard to velvet, the HSI method is not suggested.

This research establishes the potential of a non-invasive technique to provide age estimations of fabrics recovered in aquatic forensic investigations, useful when fabrics are not colonized by fauna or—on colonized fabrics—to provide more information, in association with the zoological method.

Aquatic, Hyperspectral Imaging, Postmortem Submersion Interval