FSC2101 Final Term Paper (Question A)

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1 Introduction

To investigate a recent innovation/finding in forensic science (Question A), I will review a paper from the latest issue (Volume 329) from Forensic Science International, of the title "Assessing optical remote sensing for grave detection" [Silván-Cárdenas et al., 2021].

1.1 Background

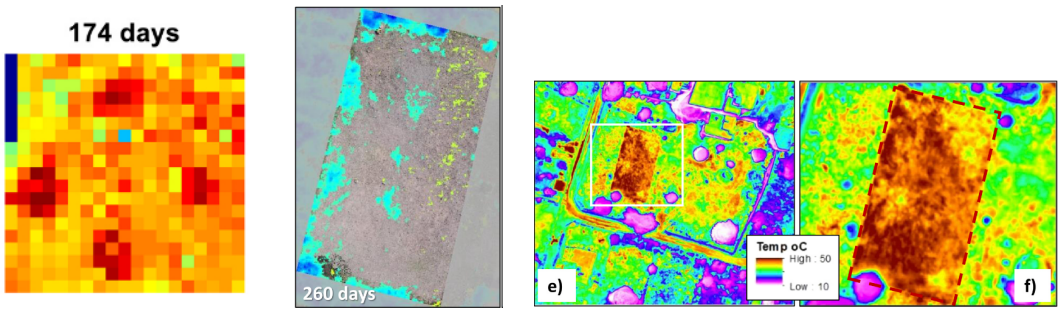
Resisitivity meters, magnetometers, thermography cameras and ground penetrating radars have been used to search for human remains buried 0m to 10m below surface [Silván-Cárdenas et al., 2021]. These methods are non-destructive and relatively fast, but can only cover very small areas due to their intense field deployment. In Mexico where clandestine graves are prevalent due to the raging drug war [Reuters, 2020], the authors investigated 3 remote sensing methods that can scan large pieces of land in a short time, namely, multi/hyperspectral sensors, thermography sensors, and unmanned aerial vehicles (UAV).

1.2 Methods of Measurements

1. **Multispectral cameras** are cameras that detect up to 12 spectra bands of light (compared to only 3 on conventional cameras), and up to hundreds of spectra bands on a **hyperspectral camera**. These cameras can capture much more details than typical cameras.
2. **Thermography sensors**, or thermal cameras are common in the post-Covid world, especially used to measure human temperatures in crowded areas.
3. Finally, **UAV photogrammetry** aims to capture full images of the site using a UAV, which is cheap and effective.

2 Questions investigated and their answers

The authors carried out 2 controlled experiments of burying pig corpses in 2 sites in Mexico, which answers question 2.1, and the other questions (2.2, 2.3, 2.4) respectively.



(a) Multispectral (b) UAV (c) Thermograph

Figure 1: Multispectral, Thermal and UAV images [Silván-Cárdenas et al., 2021]

2.1 What happens if there are confounding factors like clothes on the corpses, or lime in the land?

[Silván-Cárdenas et al., 2021] concluded:

1. A larger grave will be at least as spectrally separable than a smaller grave.
2. The presence of lime (CaO and/or $Ca(OH)_2$) does not reduce the spectral separability of the grave.
3. The presence of clothes does not reduce the spectral separability of the grave.
4. Lowering the resolution of the multispectral cameras can only reduce the spectral separability.

2.2 Can hyperspectral and multispectral sensors detect graves?

Yes, given enough time for the vegetation to grow. Decaying bodies provide ample nutrients such as Nitrogen (N) which can directly influence chlorophyll content in plants and make them green. However, decay of bodies depends on the climate and microbe; in this paper, 3.5 to 4 months were needed (under the Mexican warm climate) to see significant change in the data. See figure 1(a).

2.3 Can thermal imagery detect graves?

Yes, due the voids created by the graves after the bodies have decomposed (Figure 1(c)). However, there are anomalies such as plastic which would affect the experiment result, but the authors noted it as a useful discovery since it is common for body parts to be wrapped in plastic before buried or discarded.

2.4 Can UAV-photogrametry detect graves?

Yes, but only to a certain extent. It can detect terrain changes (such as depresion in the surface due to soil compression and body decomposition in a grave, figure 1(b)), but because it is unable to penetrate vegetation (unlike LiDAR), it "can only record the upper vegetation canopy". However, due to its cost-effectiveness, UAVs are "useful for documenting the state of a search site" [Silván-Cárdenas et al., 2021].

References

[Reuters, 2020] Reuters (2020). Remains of 59 bodies found in clandestine graves in mexico. *CNN*.

[Silván-Cárdenas et al., 2021] Silván-Cárdenas, J., Caccavari-Garza, A., Quinto-Sánchez, M., Madrigal-Gómez, J., Coronado-Juárez, E., and Quiroz-Suarez, D. (2021). Assessing optical remote sensing for grave detection. *Forensic Science International*, 329:111064.