C20 Control Point Selection for Analysis and Height Measurement From Closed-Circuit Television (CCTV) Images

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Learning Overview: The goal of this presentation is to illustrate the effects of control point selection on precision and accuracy in the analysis of CCTV footage. The hypothesis of precise and accurate measurements in the absence of control points is also presented.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by explaining that validation of the control point selection process and parameters, such as camera resolution, is an important step in presenting photogrammetric evidence with known error rates. The hypothesis that natural image landmarks can be just as robust when substituted in the place of purpose-built control point markers may significantly reduce the time and resources police are required to spend in the field, and it may enhance the analysis of CCTV evidence where measurements are involved by improving the calibration process.

Agencies may use CCTV footage to extract meaningful information about the movements, activities, and characteristics of a person of interest. One such characteristic is height, and as a class characteristic it is a powerful exclusionary tool. In addition to the capabilities of laser scanning and photogrammetry to create 3D photo-realistic reconstructions of crime scenes, there is keen interest in applying these techniques to ascertaining height measurements from recorded traces left on CCTV footage. Control point selection has shown promise in a number of studies focused on obtaining height from single-image surveillance video. Control point selection as a photogrammetric tool in crime scenes currently has limited literature—especially when it comes to establishing precision and accuracy and assessing the impact of image variables on precision and accuracy.

In this work, experiments were designed to test the variability of photogrammetric errors with image resolution. A calibration set-up with 50 purpose-made control point targets was filmed and scanned. Using a photogrammetric package, control point selection was used to achieve camera calibration, followed by derived height measurement of a physical object of known height placed in the field of view of the footage. The resolution of the original footage was digitally down-sampled in 5% increments and the measurements repeated. It was hypothesized that image resolution would be inversely proportional to precision, with an unknown effect on accuracy. The effect of uneven control point distribution within the space was also investigated. The accuracy of the measurements was externally validated using Light Detection And Ranging (LIDAR).

It was found that image resolution did systematically impact the precision of the results for height measurement and calculation of the camera location. It was observed that the greatest error range in calculated camera position and measured height was in the lowest-resolution image.

It was found that the accuracy was impacted by the nominated location of the control point in the image, which is a manual and subjective process. Concern was raised as to subjectivity of manual point selection, and the question is posed as to whether relying on automated target detection or shape-matching algorithms (which are already commercially available), would be a better option.

Follow-up experiments were conducted to investigate whether purpose-made control points could be replaced by immovable existing features within the field of view of the camera, an area of research that has limited/no existing literature. Precision and accuracy analysis using landmarks was conducted in a similar manner to the earlier height measurement, noting that existing fixed features may not be evenly distributed in the field of view.

Photogrammetry, Control Points, CCTV

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