# Assessing Reflectivity Between Substrates and Distances Utilizing the FARO M70 and Trimble X9 Scanners

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## ABSTRACT

Three-dimensional scanners are a predominant tool in various fields, including forensic investigations for documenting crime scenes and gives investigators the ability to capture the scene with high-quality imagery and measurements. Reflectivity becomes an issue with the consideration of how much of the scene is truly being captured. In this research, we are looking at the relationship of the reflectance intensity on different substrates. The research includes scanning and recording reflectivity values from three (3) predetermined distances upon four (4) selected substrates using both the FARO M70 and the Trimble X9 3D scanners. Using the reflectivity intensity obtained from each value, we can record the values of reflectivity change (averaged), based on the distance between the scanner's sensor and the substrate. To control additional variables, the front of each scanner domain will be placed at a measured distance of three (3) feet, six (6) feet, and nine (9) feet from the established substrate, capturing three scans at each distance. We anticipate seeing the data showing a direct correlation in decreased reflectivity as related to increased distance. To obtain data of repeatability, within each scan, a marked area will be set at the same measured location upon each substrate, the area will be marked using blue painter's tape. The introduced constant is anticipated to hold similar readings of reflectivity values, despite the change in the substrate to which it is adhered, across all shared distance scans. The importance of this experiment is to observe how both FARO M70 and the Trimble X9 deal with certain targets, of varying color and texture, which are typically seen within crime scene investigations.


## INTRODUCTION

The three-dimensional scanners utilized within this research were manufactured by FARO and Trimble, both companies strive to accurately capture the scene using LiDAR. As these two scanners are developed by two competing companies, internal mechanisms are likely to differ when compared. Both the FARO M70 and the Trimble X9 scanners use a method called LiDAR, which stands for Light Detection and Ranging, and uses a laser as a method to determine distance and is sometimes referred to as laser scanning or even 3D scanning. It does this by sending a laser outwards until it reflects off a surface, and comes back and into the sensor which records all the information. It records values such as the XYZ coordinates, Red Green Blue (RGB), and even the reflective (RF) values, which are calculated using the intensity value. The FARO M70 operates at 1550 nm wavelengths while the Trimble X9 operates between 1530-1570 nm.

## METHODS

In order to conduct our research we determined that the distances of three (3) feet, six (6) feet, and nine (9) feet would be sufficient to interpret different data across the four (4) different substrates. All distances were measured out with both a standard tape measure and a distometer. Each of the distances were then marked with tape on the floor to indicate where to place the front of both the FARO M70 and the Trimble X9 scanners. To verify that the scanners were both at the accurate distances once placed on the floor, the distometer was used to check each distance by holding it at the center of the scanner, which is the location of each scanner's laser sensor. Once the scanner's distances were verified, *Scotch blue Original Multi-Surface Painter's Tape* (#2090) was placed on the wall in the shape of an 'X' perpendicular to the laser's angle, which was documented as 0° (See **Figure 1** and **2**).


**Figure 1.** *Image of FARO M70 scanner at three (3) feet from the Wood Paneling substrate*


**Figure 2.** *Image of Trimble X9 scanner three (3) feet from the Wood Paneling substrate.*

Test scans were performed next and these were then uploaded into the respective software for each scanner, either FARO SCENE or Trimble RealWorks, to verify the manually-marked distances. For each of the three (3) distances, three (3) separate scans were completed so that the data average of the three (3) scans could be looked at and compared. This method was consistently conducted for all four (4) substrates: the white wall, the wood paneled wall, the TV screen, and the cement blocks. It should be noted that the FARO M70 was placed on a platform to compensate for height difference between scanners, due to size difference and sensor locations and height. For each scan, twenty-five (25) different points were taken from both the substrate and the control (the painter's tape 'X') on the respective software's used. All collected data points were obtained from a position directly above the intersection of the painter's tape on the substrate and the inverse surface area upon the tape itself. (See **Figure 3**).


**Figure 3.** *Data point selection areas on FARO SCENE software of the White Wall substrate at distance of three (3) feet.*

All data points collected were transferred into an overall Excel spreadsheet. Using the information from the spreadsheet, the data was uploaded into Microsoft Excel to create graphs of the corresponding data across the different substrates to show similarities and differences of the reflectivity values.

*Disclaimer:* It should be noted that RF values are not comparable between scanners; therefore all reviews of collected data are to be addressed within the same scanning format, FARO or Trimble, not between each other.

## RESULTS

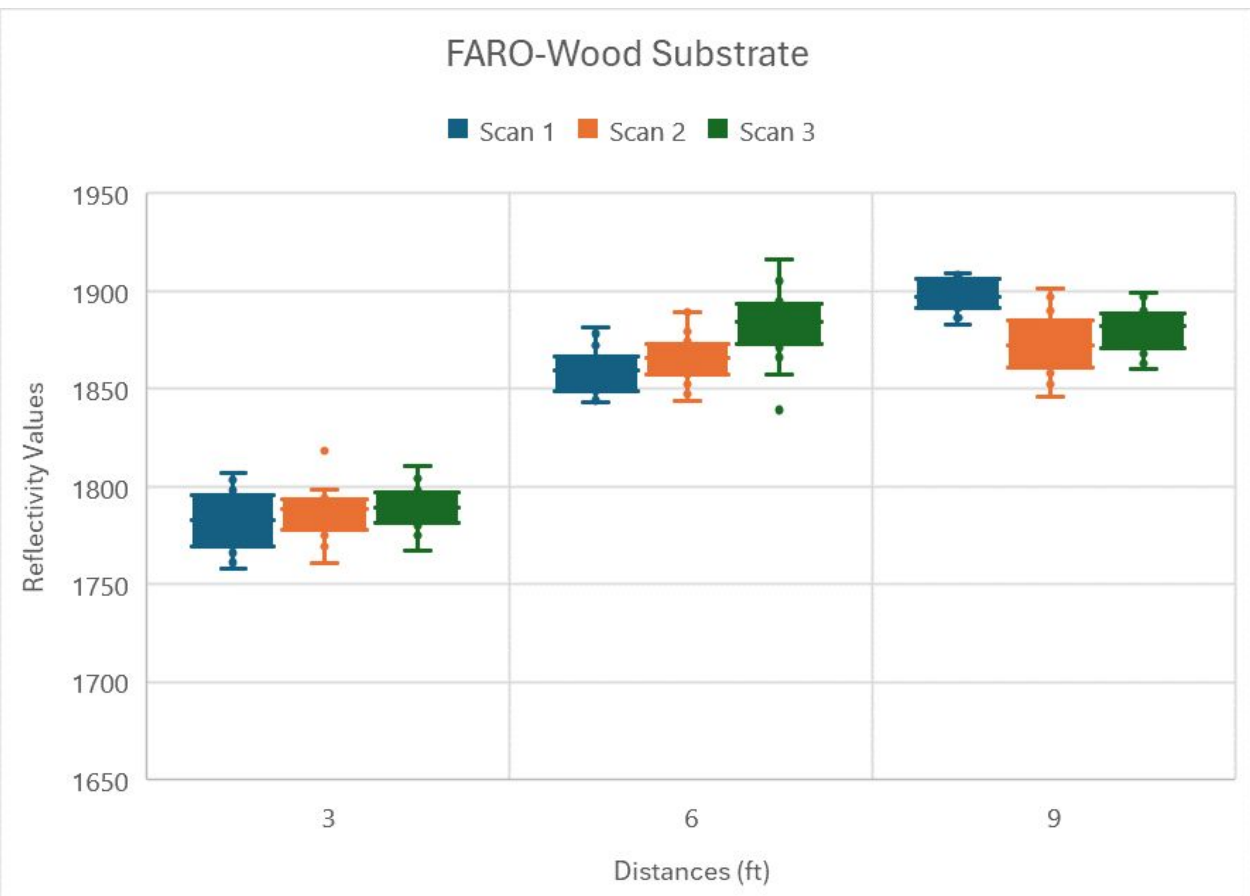


**Figure 4.** *Box & Whisker Plot of the FARO M70 Wood Substrate scans at the distances of three (3), six (6), and nine (9) feet.*

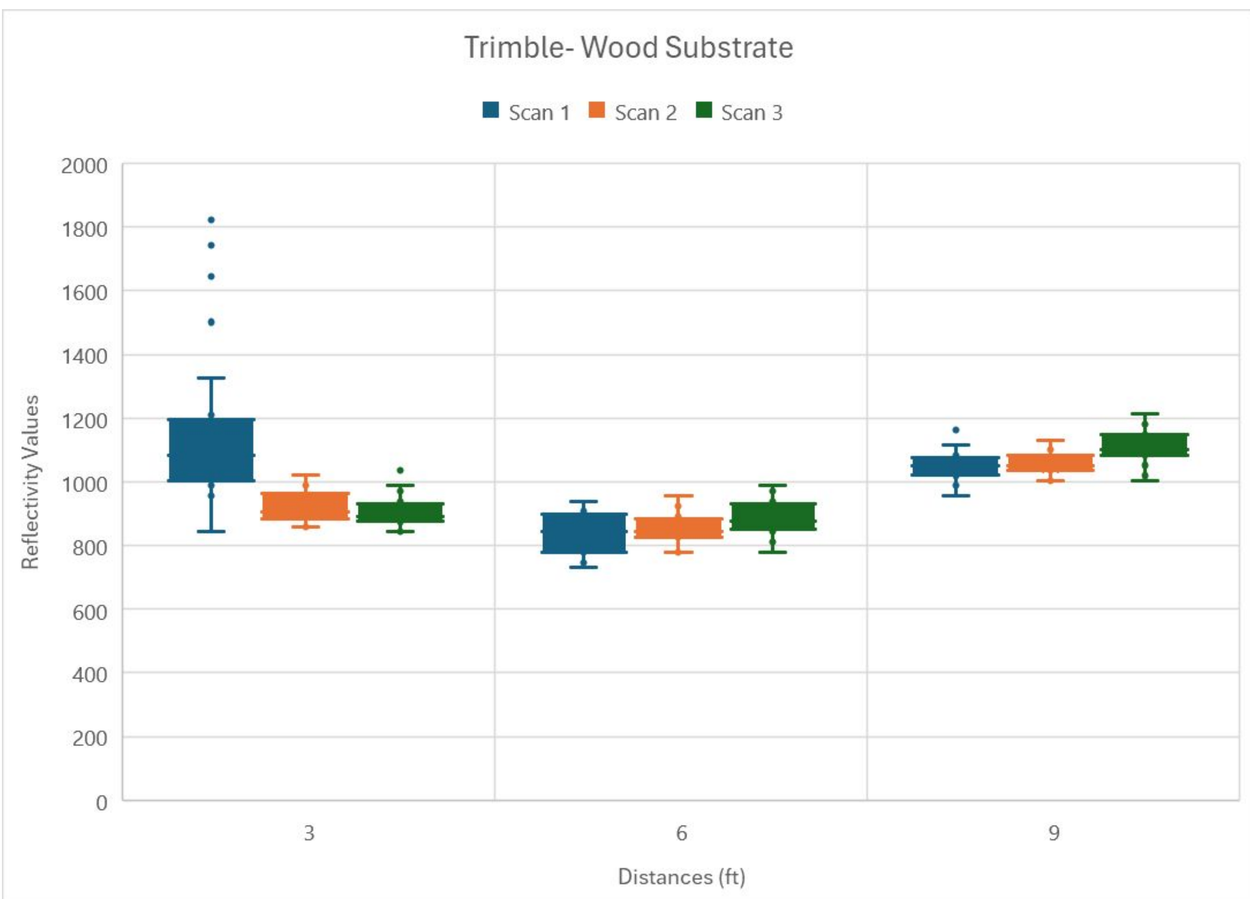


**Figure 5.** *Box & Whisker Plot of the Trimble X9 Wood Substrate scams at three (3), six (6), and nine (9) feet.*

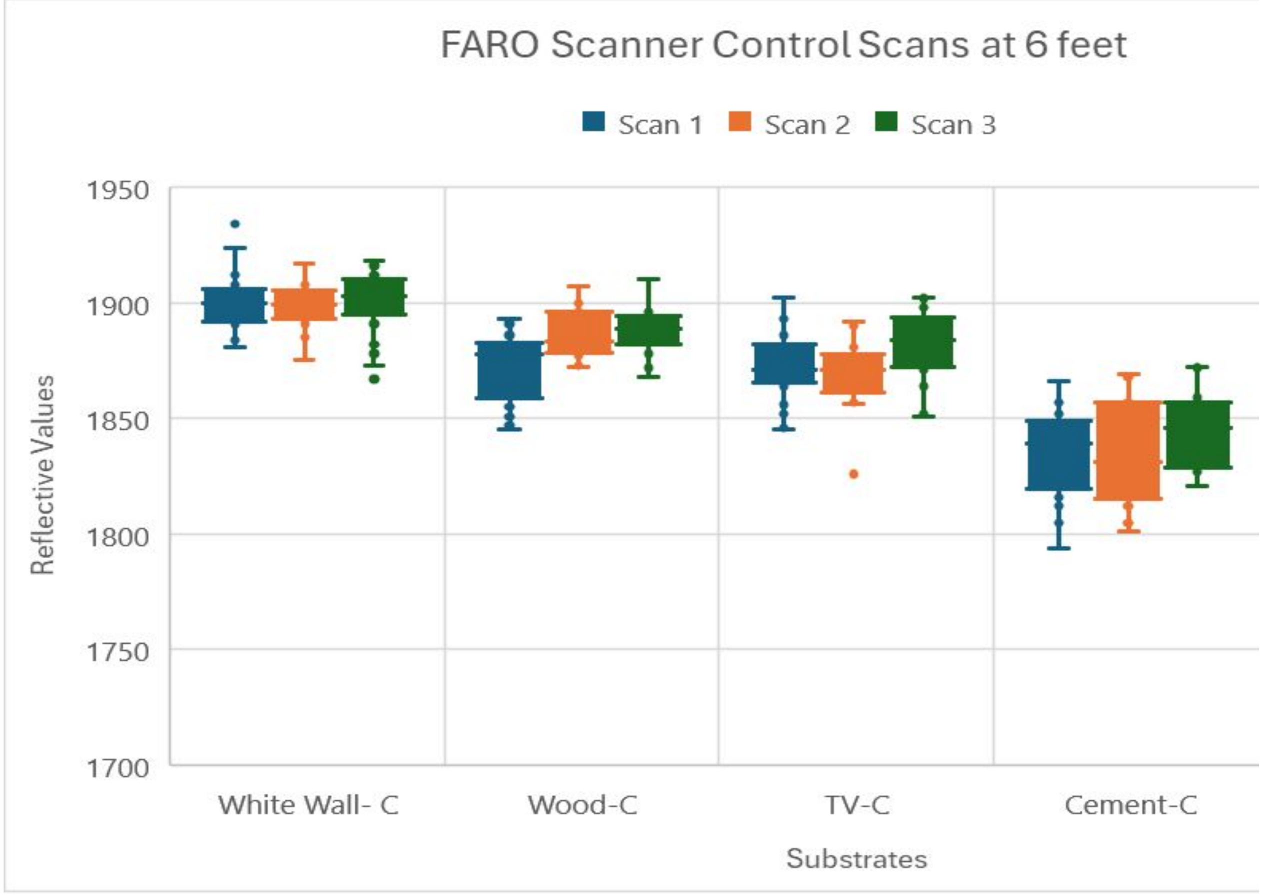


**Figure 6.** *Box & Whisker Plot of the FARO M70 Control Scans at six (6) feet.*

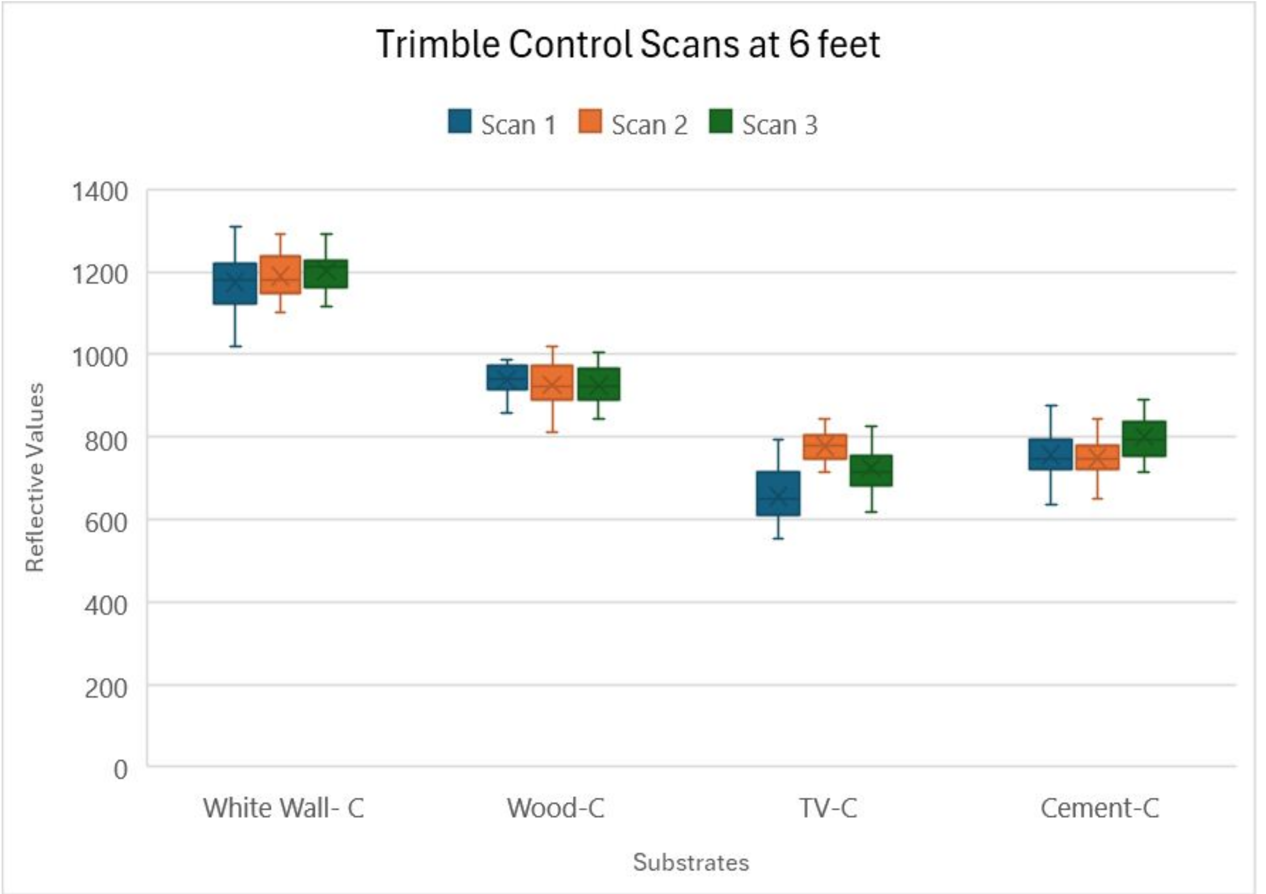


**Figure 7.** *Box & Whisker Plot of the Trimble X9 Control Scans at six (6) feet.*

## CONCLUSIONS

From this study, it was found that the data collected does not support the original hypothesis of the research and it appears to be more randomized. There is not a clear inverse relationship between the distances and reflectivity. Based on the recorded data, it appears as though the FARO M70 shows more linear repeatability of the RF values. Through this study, we found that it would be more preferable to have the Trimble X9 scanner with its T10 Tablet accessory and the FARO SCENE software for obtaining and locating data points if these technologies were able to be combined. Existing research material was minimal on reflectivity to reference for this study; therefore, obtained data was limited to only observational assessment.

For additional studies to be completed, additional effort to identify and isolate fluctuating variables is needed. Despite efforts made to control the primary variables of distance, substrate and lighting, obtained data on the control supports an unidentified confounding factor influencing repeatability.

## References


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