Towards Reliable TLS Intensity Measurements: Assessing Repeatability and Temperature-Induced Effects

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SUMMARY

Intensity values recorded by terrestrial laser scanners (TLS) contain valuable information about surface properties and structures. This makes them a promising tool for damage monitoring and surface characterization. However, the repeatability of TLS intensity values remains poorly understood and is influenced by numerous instrumental and environmental factors. While the effects of incidence angle and distance on intensity have been widely studied, little attention has been given to influences such as ambient temperature or warm-up effects.

This study investigates the repeatability of TLS intensity measurements under varying ambient and instrument temperatures. Using a Z+F Imager 5016, a strong linear correlation was identified between measured intensity and ambient temperature, with a nearly linear increase of up to 15% between 0 °C and 40 °C across several target materials. In addition, experiments with a Leica RTC360 revealed substantial intensity variations within the first 15 scans despite constant ambient temperature.

To mitigate these effects, two correction approaches were developed: (1) an instrument-based correction utilizing internal temperature sensor data to compensate for thermal influences, and (2) a measurement-based correction requiring no auxiliary sensor input. Both methods strongly reduced the standard deviation of temperature-induced intensity variation, in some cases by a factor of six. While the measurement-based method is sensor-independent, it exhibits minor systematic shifts between multiple measurements. In contrast, the instrument-based correction yields more stable and consistent results across repeated measurements.

The proposed correction methods enable more repeatable intensity measurements, supporting surface analysis and long-term TLS-based monitoring, if instrument and environment conditions are

properly monitored and compensated for.