Section 1.Introduction to the Laser Scanning Guide#

1.4 Current issues or concerns

1.4.1 Limitations of technology

The advantages of laser scanning are well known and have been cited in numerous publications. Laser scanning provides the ability to quickly, accurately, and remotely take thousands of measurements on any surface or landscape. The results from scanning produce a digital, scaled replica of the original object that can be observed and analyzed. As mentioned, some scanners also acquire RGB information which adds an additional photorealistic quality to scan models, and many also record intensity data, which can aid in the interpretation of materials. While laser scan data is initially handled as a point cloud, numerous products can be derived from the data including polygonal meshes, cross sections, and high precision measurements. In addition, scan processing software provides additional analyses and measurement options that are often not possible on the physical object such as extracting or accentuating features or subsections of an object or removing the color information from an objects surface to reveal subtle details in surface topography. In short, laser scan data, if acquired and processed correctly, can provide a digital copy of an object or environment that can be viewed and analyzed remotely.

While laser scanning has numerous advantages, there are also limitations to the technology that should be considered when evaluating whether or not scanning is suitable for a specific application. For example, certain surfaces such as or black and highly reflective surfaces can be very difficult to scan. Black materials absorb the laser energy while reflective surfaces tend to scatter the laser causing any data returned to be noisy. Translucent materials such as marble or bone are also problematic as the laser can actually penetrate these surfaces causing noisy data results for smooth surface areas.

Two additional considerations are beam divergence and data shadowing. Beam divergence is the expansion of the laser beam (in diameter) as it moves outward from the instrument. The graphic below (Figure 6) shows the effect of beam divergence (indicated by laser spot size in the graphic) at different ranges. The location of the measured point returned to the sensor can be anywhere within the bounds of the laser spot size. Therefore the data at greater distance can be less reliable and less accurate. There are ways to minimize the effects of beam divergence such as focusing the laser at greater distances but beam divergence is still an important consideration in projects.

Figure 6: The effect of beam divergence at different ranges.

Data shadowing or laser shadowing is also common with terrestrial laser scanning. The laser beam essentially acts as a light source which will cause objects to shadow one another and holes or voids to appear in the data.

Figure 7: Example of Laser Shadowing

The effects of laser shadowing can be minimized by acquiring multiple scans from multiple angles. However, in some cases, for example when trees or vegetation grow very close to a structure, data shadowing is unavoidable. Data shadowing can also occur when you have limited vantage points for scanning. For example when trying to acquire scans of roof features on a building from the ground, there are portions of the roof that will always be in shadow unless a high vantage point is available. While data shadowing is not completely unavoidable, the effects of shadowing (data voids) should be minimized in a project.

Finally, in addition to collecting surface measurements for an object, many laser scan systems include the option to collect intensity as well as color/RGB information. Intensity data is a measure of the reflective value of a surface and is typically displayed as grayscale whereas RGB data is full color.

Figure 8: Examples of Intensity and RGB data

While RGB collection adds a photo-realistic quality to scans, it can be difficult to collect accurate color information for an object. RGB color captured internally or externally to the scan system is subject to the lighting environment in which a scan is taken. If the lighting changes or fluctuates during the acquisition process, individual scans will vary in brightness and contrast across the object and can result in color artifacts if not properly adjusted during data processing. In short, when combining multiple scans across an object or structure, it can be a challenge to get uniform and consistent color across the object.

1.4.2 Sources for error

While some common sources for error in laser scanning were briefly touched upon in the section above, there is an excellent, comprehensive discussion of error generation in Section 2.6 of the 'Theory and Practice on Terrestrial Laser Scanning' (3D Risk Mapping 2008). In this section, you will find detailed explanations concerning the effects of beam divergence, surface reflectivity, and environmental conditions.
