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Automatic mapping direct sun glares on roads with point clouds. Case study of EP2005, Vigo, Spain

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Abstract:

According to data from the *Dirección General de Tráfico* (DGT), 5% of traffic accidents in Spain are caused by sun glares during twilight hours (EuropaPress, 2018) and after a sun glare, recovery of visual functions can take up to 50 seconds. Sun glares affect both people and machine vision systems, where the image is burned by direct exposure to the sun. In this work, a method is applied to detect direct sun glares on drivers along a road for any time and date from point clouds.

The selected study area is the road EP2005 in Vigo (Spain). This road connects the highway with the university campus and is especially frequented in the morning. Given the main hours of use and the south and upward orientation, this road presents several areas where the sun hits drivers head-on. The road was acquired with a LYNX Mobile Mapper of Optech and point clouds of the surroundings are available the Spanish National Geographic Information Centre.

The proposed method is based on point clouds acquired with Mobile Laser Scanning (MLS) and Airborne Laser Scanning (Figure 1). The MLS point clouds are used to identify solar collisions with nearby road objects (e.g., houses or vegetation), while the ALS point clouds detect collisions with distant road objects (e.g., mountains). The position of the driver is obtained from the MLS trajectory, and the human field of view is restricted to 120º degrees (Tara et al., 2021). The position of the Sun, defined the solar altitude and azimuth, is calculated for any day and time from solar geometry equations (Sproul, 2007). To check if a sun ray is incident on the driver's position and field of view, the MLS and ALS point clouds are processed (outliers' removal, density reduction and Delaunay triangulation) and merged, in order to calculate intersections between mesh polygons and sun ray lines.

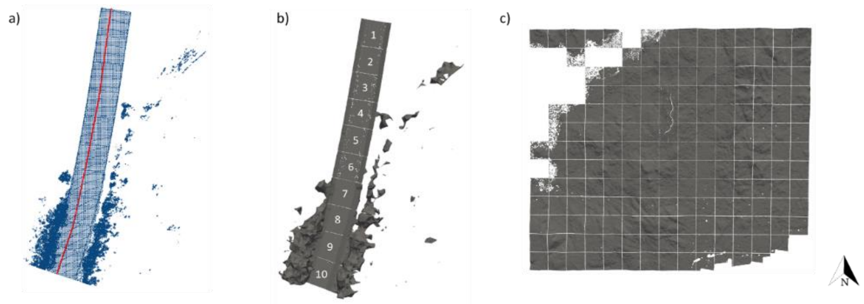

Figure 1. EP2005 road: a) MLS point cloud with vehicle trajectory (red), b) MLS mesh, c) ALS mesh

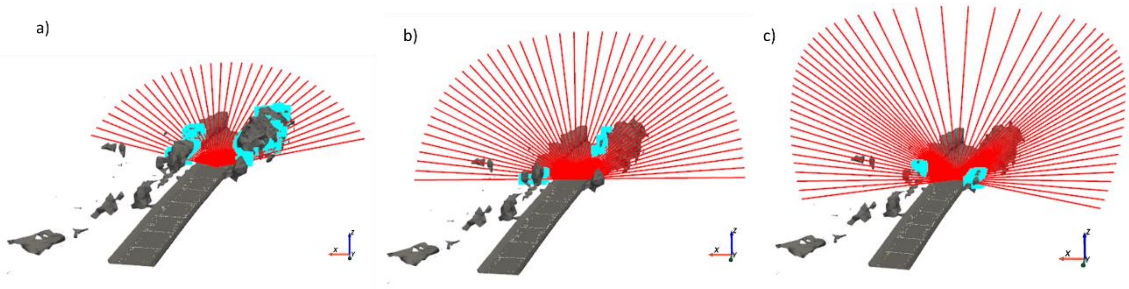

Figure 2. Collisions (light blue points) with nearby road obstacles: a) Winter solstice, b) Equinoxes, c) Summer solstice.

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As a result, the solar incidence at the different seasons is clearly identified, exemplified by the solstices and equinoxes in Figure 2. By selecting different points along the MLS trajectory, it was possible to generate a map (Figure 3) showing the hours where the sun strikes on driver field of view and the evolution throughout the day. In this way, it is possible to generate a sun glare map and take appropriate measures focused on these areas, by means of traffic signs, warnings in navigation apps and more robust artificial vision algorithms.

Future work will focus on the integration of meteorological information and the analysis of indirect sun glares caused by puddles on pavement. A more detailed version of the methodology is available at doi.org/10.3390/rs14061456.

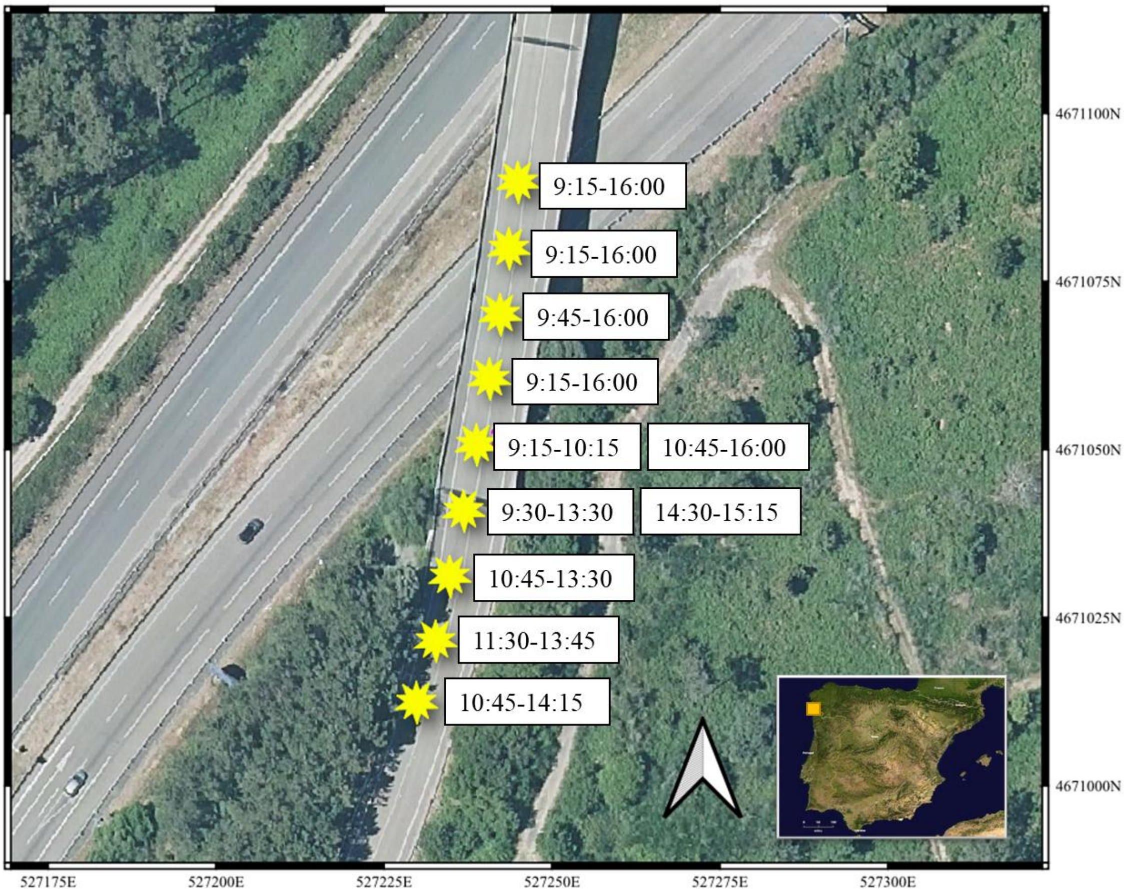

Figure 3. Map of direct sun glare in EP2005 road during winter solstice

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