March 2022

Navigation Suggestions to Select Driving Route with Low Sun Glare

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ABSTRACT

Sun glare can be a danger to motorists because it can impede a driver's vision and cause accidents, especially when it occurs suddenly and surprises the driver. Yet, directions provided by navigation apps do not currently include the amount of sun glare expected to be encountered along a given route at the time of travel. This disclosure describes techniques to score a given route based on the amount of sun glare likely to be encountered at the estimated time of travel along a given route. The sun glare score for a route is obtained based on individual sun glare scores for road segments within the route based on factors such as terrain, weather, historical traffic incident information, etc. The scores for the various routes can be used when suggesting routing options. The techniques can be integrated within any application, device, or platform that includes maps, navigation, and Advanced Driver Assistance Systems (ADAS) functions, or as part of a self-driving vehicle.

KEYWORDS

- Sun glare
- Route score
- Navigation
- Digital map
- Driving directions
- Driving safety
- Three-dimensional terrain

BACKGROUND

Sun glare can be a danger to motorists because it can impede a driver's vision and lead to accidents, especially when it occurs suddenly and surprises the driver. Drivers are often more surprised by sun glare than by other environmental factors, such as fog, ice, snow, rain, etc. The severity of accidents can be higher in the presence of sun glare. Moreover, cascading accidents can occur when drivers are unprepared for the effects of sun glare.

People typically navigate by consulting directions provided by apps on the automobile console or on their devices, such as smartphones. Along with street names or numbers and turns, such guidance often includes other information associated with the route, such as speed limit, nearby fuel outlets, points of interests, etc. However, such information does not currently include the amount of sun glare expected to be encountered along a given route at the time of travel. Therefore, users do not have the option to choose directions that minimize the likelihood and/or amount of sun glare encountered along the route. In fact, law enforcement recommends that people avoid using navigation apps in certain adverse situations, which can include excessive sun glare.

DESCRIPTION

This disclosure describes techniques to score a given route based on the amount of sun glare likely to be encountered at the estimated time of travel. The sun glare score for a route is obtained by summing the individual sun glare scores for each road segment within the route based on a detailed terrain map of the road segment in the navigable network of roads.

The sun glare score $G(S_i, t_i)$ for a road segment i within a route R at a given time t_i is a function of one or more of various relevant factors such as :

- Direction of travel;

- Slope of the road segment;
- Position of the sun at time t_i;
- Amount of (predicted) cloud cover in the direction of the sun;
- Road surface reflectivity based on predicted water presence from rain, snow, sleet, broken pipes, etc.;
- Reflectivity of nearby structures, such as buildings, bridges, etc.;
- Effect of shadows from nearby objects, such as buildings, trees, mountains, etc.; and
- Locations and times of past traffic incidents attributable to sun glare;

For instance, the terrain information can be used to determine the angle of the road with respect to the position of the sun while factoring in any possible obstructions to compute the angle that the sun rays would make with the center plane of the driver’s field of vision. A three-dimensional model of the structures (e.g., buildings) and the surrounding terrain can be consulted to predict the locations and angles of shade that could mitigate the impact of sun glare. In addition, weather forecasts can be employed to predict sun glare. For example, cloud cover can block the sun while wet road surfaces can amplify it owing to reflection. Historical data on locations and causes of traffic incidents can indicate whether sun glare has caused accidents within a given road segment at particular times of day, thus suggesting a higher likelihood of encountering sun glare within that road segment at such times. Historical data can additionally account for the role of reflective surfaces, such as glass buildings or billboards, that may create sun glare even for drivers traveling in a direction away from the sun.

The sun glare score G(R) for a route is the sum of the individual scores S_i for all segments within that route: $G(R) = \text{Sum } \{G(S_i, t_i)\}$ (i = 1 to N) where N is the total number of road segments within the route. Each potential route can thus be associated with a respective sun glare score based on the estimated time of travel. The sun glare scores for each routing option can be presented within a navigation app to help the user choose a route by factoring in the impact of sun glare. Alternatively, or in addition, the recommended routing choice within the navigation app can be the route that has the lowest sun glare score while keeping the overall travel time within a certain threshold above the minimum. Alternatively, a recommendation of a modified start time for the travel that minimizes sun glare while simultaneously keeping the travel time or distance optimally minimum can be provided to the user.

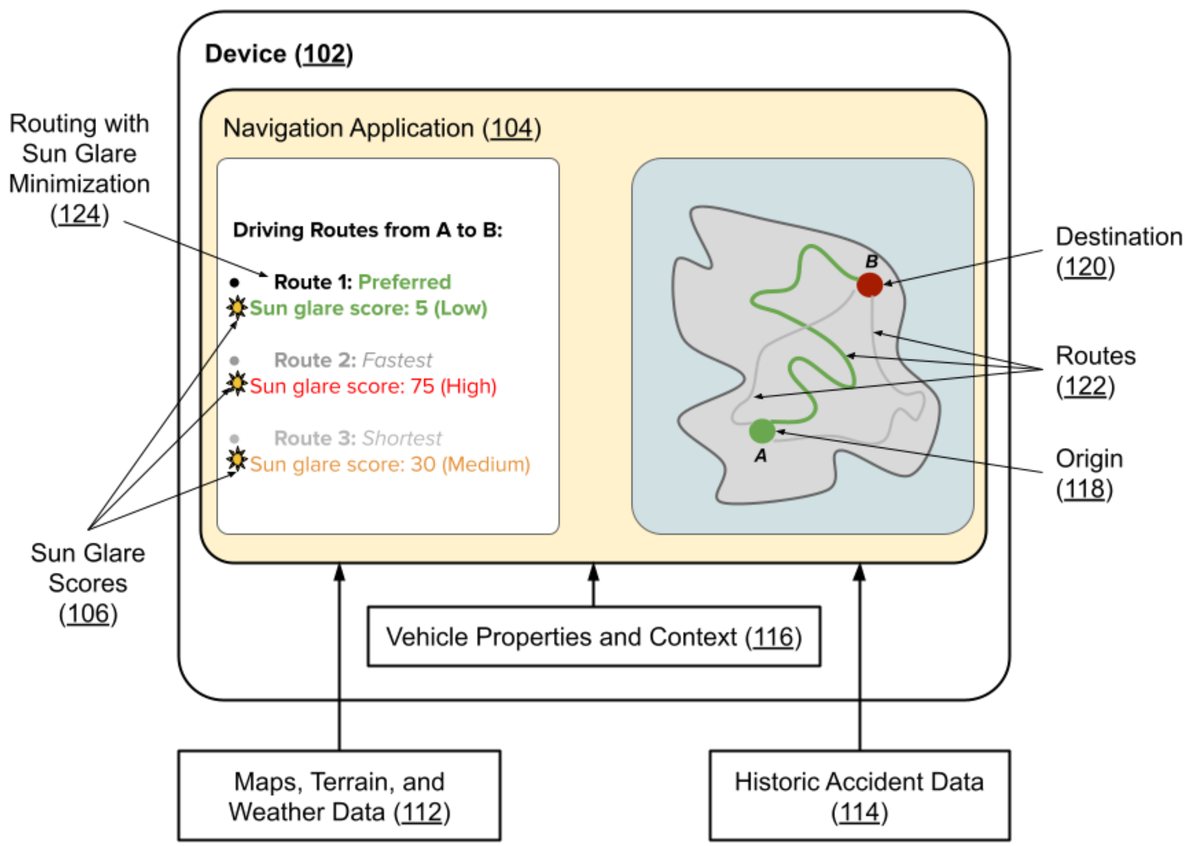

Fig. 1: Suggesting a routing option that minimizes sun glare along the route

Fig. 1 shows an example of operational implementation of the techniques described in this disclosure. A user seeks driving routes (122) within a navigation application (104) on a device (102) to go from an origin (118) to a destination (120). Sun glare scores (106) are calculated for each of the routing options by combining relevant information such as maps, terrain, and weather data (112), historic traffic incident data (114), and with user permission, vehicle properties and context (116), such as location, speed, direction, etc. The user is recommended the route that minimizes sun glare (124) by giving it preference over faster or shorter routes along which significantly higher sun glare is predicted.

As Fig. 1 shows, in many cases, the most direct routing option is not the one with the lowest sun glare. For instance, if traveling west in the evening, the most direct route is likely to involve high amounts of sun glare. The described techniques can provide a less direct route where the sun glare is minimal because the sun is at more oblique angles and/or obscured by the terrain or built structures.

The value for threshold of permissible deviation between a route that minimizes the time or distance and a route that minimizes sun glare can be set by the developers of the navigation app and/or specified by the users and/or determined dynamically at runtime. Additionally, users can specify routing trade-offs in one or more of several ways such as: upper bound in terms of percentage of optimal travel time or distance (e.g., 130%); cap on the total additional time or distance over the minimum time or distance, respectively; etc. Alternatively, users can choose to override the routing suggestion based on minimization of sun glare and choose another route instead.

Even along a route that minimizes the likely amount of sun glare as described above, there may be times at which the sun glare is more intense than desirable. At such times, with user permission, the driver can be alerted to expect high amounts of sun glare, and can be provided relevant safety tips for mitigating the impact of the glare, such as “ensure clean windshield,” “turn on the headlights,” “slow down,” “keep greater following distance,” etc. Such tips can be provided when caution is particularly warranted at specific points during the drive, such as prior to rounding a bend, exiting shaded portions of the road, turning into a segment bright with sunlight, etc.

When appropriate, such as during longer drives, recommendations can be provided that the user pull off the road and wait until the impact of intense sun glare has dissipated. For example, such recommendations may be appropriate if an alternate route that minimizes sun glare would add substantial time and distance to the drive. In such cases, the optimal time and location for pulling over can be determined based on various points of interest, such as gas stations, charging ports, restaurants, recreational facilities, rest areas, etc., along the road.

The techniques described in this disclosure can be implemented by leveraging existing data sources, such as three-dimensional terrain maps, building geometry, weather forecasts, etc. The techniques can be integrated within any application, device, or platform that includes maps, navigation, and Advanced Driver Assistance Systems (ADAS) functions. The techniques can also be incorporated within self-driving cars in which the navigation is based on visible light sensors that can be impacted by the presence of sun glare.

Additionally, the techniques can be implemented as a subscription service for relevant authorities to determine whether intense sun glare necessitates mitigating measures such as posting warnings on Variable Message Signs (VMS) on the road, reducing speed limits, temporarily closing affected road segments, etc. Implementation of the techniques enables users to obtain routing information that optimizes safety, comfort, and convenience, thus enhancing the driving experience.

Further to the descriptions above, a user may be provided with controls allowing the user to make an election as to both if and when systems, programs or features described herein may enable collection of user information (e.g., information about a user's requests for driving directions, vehicle type, a user's preferences, or a user's current location), and if the user is sent content or communications from a server. In addition, certain data may be treated in one or more ways before it is stored or used, so that personally identifiable information is removed. For example, a user's identity may be treated so that no personally identifiable information can be determined for the user, or a user's geographic location may be generalized where location information is obtained (such as to a city, ZIP code, or state level), so that a particular location of a user cannot be determined. Thus, the user may have control over what information is collected about the user, how that information is used, and what information is provided to the user.

CONCLUSION

This disclosure describes techniques to score a given route based on the amount of sun glare likely to be encountered at the estimated time of travel along a given route. The sun glare score for a route is obtained based on individual sun glare scores for road segments within the route based on factors such as terrain, weather, historical traffic incident information, etc. The scores for the various routes can be used when suggesting routing options. The techniques can be integrated within any application, device, or platform that includes maps, navigation, and Advanced Driver Assistance Systems (ADAS) functions, or as part of a self-driving vehicle.

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