Shade-aware Routing

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Pedestrians are at risk of discomfort and long-term skin damage due to radiation from the sun. Prolonged exposure to UV radiation is the primary cause of such damage, making shade an important factor for pedestrian safety. If shade coverage of the environment is known in advance, we can plan routes minimizing UV exposure or maximizing time spent in shade. Our solution models the city geometry with OSM data and closely approximates the shade coverage for urban environments. The algorithm is implemented in JavaScript and the route planning tool is presented as a web application. We also quantify the opportunities to use shaded navigation in urban environments and compare it to shortest path planning in terms of safety from sunburns. We show that it is useful to seek shade in urban environments even in situations where the shade coverage is the lowest.

References

[1] OpenStreetMap contributors, *Planet dump retrieved from https://planet.osm.org,* 2017.

[2] R. N. M. I. (KNMI), *Tropospheric Emission Monitoring Internet Service,* 2017?.

[3] V. Agafonkin, *SunCalc: A tiny JavaScript library for calculating sun/moon positions and phases.,* 2011.

[4] M. Arnold, E. de Vries, D. C. Whiteman, A. Jemal, F. Bray, D. M. Parkin and I. Soerjomataram, "Global burden of cutaneous melanoma attributable to ultraviolet radiation in 2012," *International Journal of Cancer,* vol. 143, pp. 1305-1314, 2018.

[5] T. Authors, *Three.js – JavaScript 3D library,* 2010.

[6] L. Da, R. Chhibba, R. Jaiswal, A. Middel and H. Wei, *Shaded Route Planning Using Active Segmentation and Identification of Satellite Images,* 2024.

[7] K. Deilami, J. Rudner, A. Butt, T. MacLeod, G. Williams, H. Romeijn and M. Amati, "Allowing Users to Benefit from Tree Shading: Using a Smartphone App to Allow Adaptive Route Planning during Extreme Heat," *Forests,* vol. 11, 2020.

[8] Eurostat, *Walking and cycling at least 30 minutes per day by sex, age and educational attainment level,* Eurostat, 2022.

[9] D. Fiorello, A. Martino, L. Zani, P. Christidis and E. Navajas-Cawood, "Mobility Data across the EU 28 Member States: Results from an Extensive CAWI Survey," *Transportation Research Procedia,* vol. 14, pp. 1104-1113, 2016.

[10] T. B. Fitzpatrick, "The Validity and Practicality of Sun-Reactive Skin Types I Through VI," *Archives of Dermatology,* vol. 124, pp. 869-871, June 1988.

[11] T. Litman, "Cool walkability planning: Providing pedestrian thermal comfort in hot climate cities," *Journal of Civil Engineering and Environmental Sciences,* vol. 9, p. 79–86, 2023.

[12] O. Mohamed and H. Appling, "Clinical Assessment of Gait," in *Orthotics and Prosthetics in Rehabilitation (Fourth Edition)*, Fourth Edition ed., K. K. Chui, M. ". Jorge, S. Yen and M. M. Lusardi, Eds., St. Louis (MO), Elsevier, 2020, pp. 102-143.

[13] F. Moura, P. Cambra and A. Gonçalves, "IAAPE -Pedestrian accessibility and attractiveness assessment tool when planning for walkability," October 2014.

[14] A. NaNs!, *Parasol Navigation: Optimizing Walking Routes to Keep You in the Sun or Shade,* 2018.

[15] U. S. D. of Agriculture, *NAIP: National Agriculture Imagery Program.*

[16] C. Olaverri Monreal, M. Pichler, G. Krizek and S. Naumann, "Shadow as Route Quality Parameter in a Pedestrian-Tailored Mobile Application," *IEEE Intelligent Transportation Systems Magazine,* vol. 8, pp. 15-27, 2016.

[17] P. Parsons, R. Neale, P. Wolski and A. C. Green, "The shady side of solar protection," *Medical Journal of Australia,* vol. 168, 1998.

[18] StrandedKitty, *streets.gl: OpenStreetMap 3D renderer powered by WebGL2,* 2020.

[19] M. Valbuena, J. Nova and G. Sánchez, "Minimal Erythema Dose: Correlation with Fitzpatrick Skin Type and Concordance Between Methods of Erythema Assessment in a Patient Sample in Colombia," *Actas Dermo-Sifiliográficas (English Edition),* vol. 111, June 2020.

[20] C. Vasilikou and M. Nikolopoulou, "Outdoor thermal comfort for pedestrians in movement: thermal walks in complex urban morphology," *International journal of biometeorology,* vol. 64, p. 277–291, 2020.

[21] H. Wolf, A. R. Vierø and M. Szell, *CoolWalks: Assessing the potential of shaded routing for active mobility in urban street networks,* 2024.