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Cool Routes: Real-Time Human Thermal Exposure Routing

Citation

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Pedestrians in hot, arid cities face significant health risks from extreme heat, especially during prolonged exposure to solar radiation. Existing routing tools typically rely on coarse thermal indicators like air or surface temperature and fail to capture microclimatic conditions relevant to human thermal exposure. We present *Cool Routes*, a web-based pedestrian navigation tool that identifies thermally comfortable routes using mean radiant temperature (*MRT*) as the impedance metric. *MRT* forecasts are generated at 1-m resolution using the SOLWEIG model with meteorological inputs from a forecast API and 2.5D urban form from LiDAR data. The tool precomputes hourly *MRT* maps overnight and intersects them with a network of walkable paths, enabling routing via a modified Dijkstra algorithm to minimize average *MRT*. Implemented on the Arizona State University campus, *Cool Routes* was tested with 500 origin-destination pairs across 12 clear days in different seasons. Rerouting occurred in >70% of cases, with average detours <3% longer than the shortest path, reducing average *MRT* by up to 3.84 °C in cool months. To validate tool accuracy, *MRT* measurements from five recommended routes were collected using MaRTy, a mobile biometeorological platform. Comparison with simulated *MRT* yielded a systematic root mean square error (RMSE) of 4.7 °C, a mean absolute error (MAE) of 6.2 °C, a mean bias error (MBE) of –2.0 °C, and a Willmott index of agreement of 0.73. Despite some errors due to shade mismatches, *Cool Routes* reliably identifies heat-safe pedestrian paths and offers a scalable approach for real-time thermal comfort routing in cities.

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