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Eyes on the Street, Mind on the Ride: Decoding Stress in Active Mobility

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Abstract:

Stress is an important factor influencing our mobility choices. Existing studies, primarily conducted in controlled lab settings, fail to capture the real-world complexities of stress and dynamic travel behavior. By investigating human-related and spatial factors affecting the stress levels of individuals, we can develop targeted interventions in mobility planning based on strong empirical evidence (e.g., Kovacs-Györi & Resch, 2021). In this study, we focus on the following key questions:

- Which spatial factors encourage and discourage active mobility choices such as walking or cycling?
- What are the stress indicators to be measured to evaluate a person's active mobility experience?

Our research aims to develop a generic and transferrable mixed-methods approach for evaluating the stress level of cyclists and pedestrians. This approach incorporates multimodal wearable sensor technology (EDA wristbands and finger electrodes, eye tracking glasses, egocentric cameras, and VR headsets), self-reports (qualitative feedback), and spatial factors in the immediate surroundings affecting a person's active mobility experience. We plan to design and validate a methodological and empirical framework, which is transferable across cities, stakeholders, and use-cases in controlled laboratory setting and real-world user experiments to capture naturalistic active mobility behavior. Geo-referenced sensor measurements from wearables equipped with GPS enable us to pinpoint potential influences of immediate surroundings causing a particular stress reaction. Building on our previous eye tracking studies, we know that people's visual attention is affected by the landmarks due to the changes in visual saliency and visual clutter. Larger but simpler elements like hydrographic areas, or very small but distinctive and informative elements like road junctions attract more attention (Keskin et al., 2023). In this context, we plan to use saliency maps as a ground truth to associate and visualize a person's attention toward spatial elements in the immediate surroundings. By integrating eye tracking, we do not only aim to leverage the visual attention characteristics of individuals but also to improve our existing Moment of Stress (MOS) detection algorithm utilizing EDA signals (Ehrhart et al., 2022; Moser et al., 2023) in terms of its accuracy, robustness, and generalizability. Next to the sensor modalities and qualitative user data, we will enrich our MOS detection model with open-source georeferenced datasets which are relevant to stress in a broader or specific contexts. The datasets we are currently experimenting are street and network (from OSM), greenspaces and urban density using Urbanity python package created by (Yap et al., 2023), and climate and meteorological data such as air quality and temperature (Meteostat python library). **Figure 1** summarizes the input and output data of the study.

With the subsequent geovisualizations, we will demonstrate MOS data at street level through map-matched GPS coordinates of user's mobility data. In this context, we have developed a decision support tool: a QGIS hotspot maps plugin which calculates the Getis-Ord Gi* statistic and visualizes the distribution and local clustering of stress situations within a given area, pinpointing potentially concerning locations. By analyzing these visualizations, we aim to uncover implicit spatiotemporal relationships between active mobility and stress and correlating them with surrounding spatial factors. Ultimately, this will inform decision-making regarding individual mobility choices and interventions to enhance the overall mobility experience.

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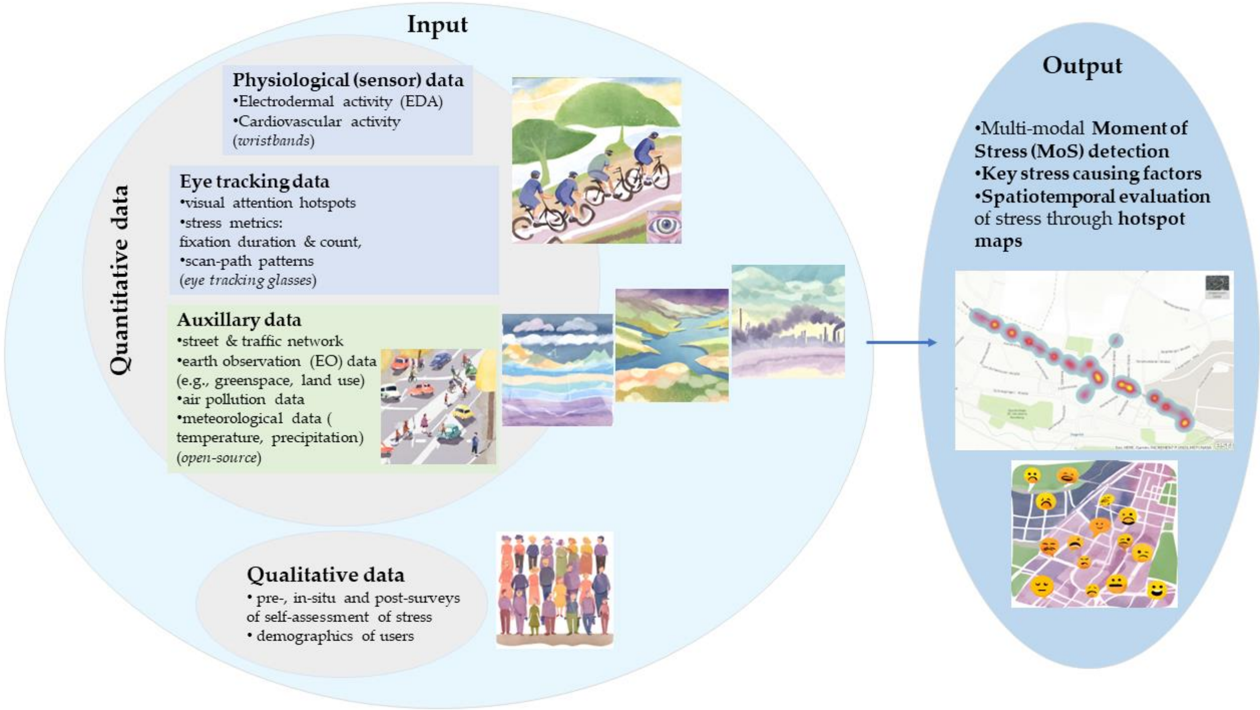

Figure 1: Input data sources and the planned output of our model

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