Resilience for Ground Transportation: Remote Operation of Automated Vehicles as Part of Crisis Management

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- In the age of **climate change**, civil protection agencies need to prepare for increasingly frequent and complex interventions. This requires streamlining skills and efforts across disciplines and domains.
- At the German Aerospace Center (DLR), multiple institutes from the aeronautics, space, energy, transport and security domains have joined forces to provide **technological solutions for disaster management**. In the **RESITEK** project (Resilient Technologies for Civil Protection [1]), DLR researchers from various domains integrate their technologies into a comprehensive **system to support continuous situation monitoring** *(Fig. 1)*. The system will aid the deployment of emergency services in crises. In climate-related disasters, a key challenge is the quick deployment of disaster-specific transportation capabilities, e.g., for evacuation of residents from hazardous areas or delivery of relief aid.

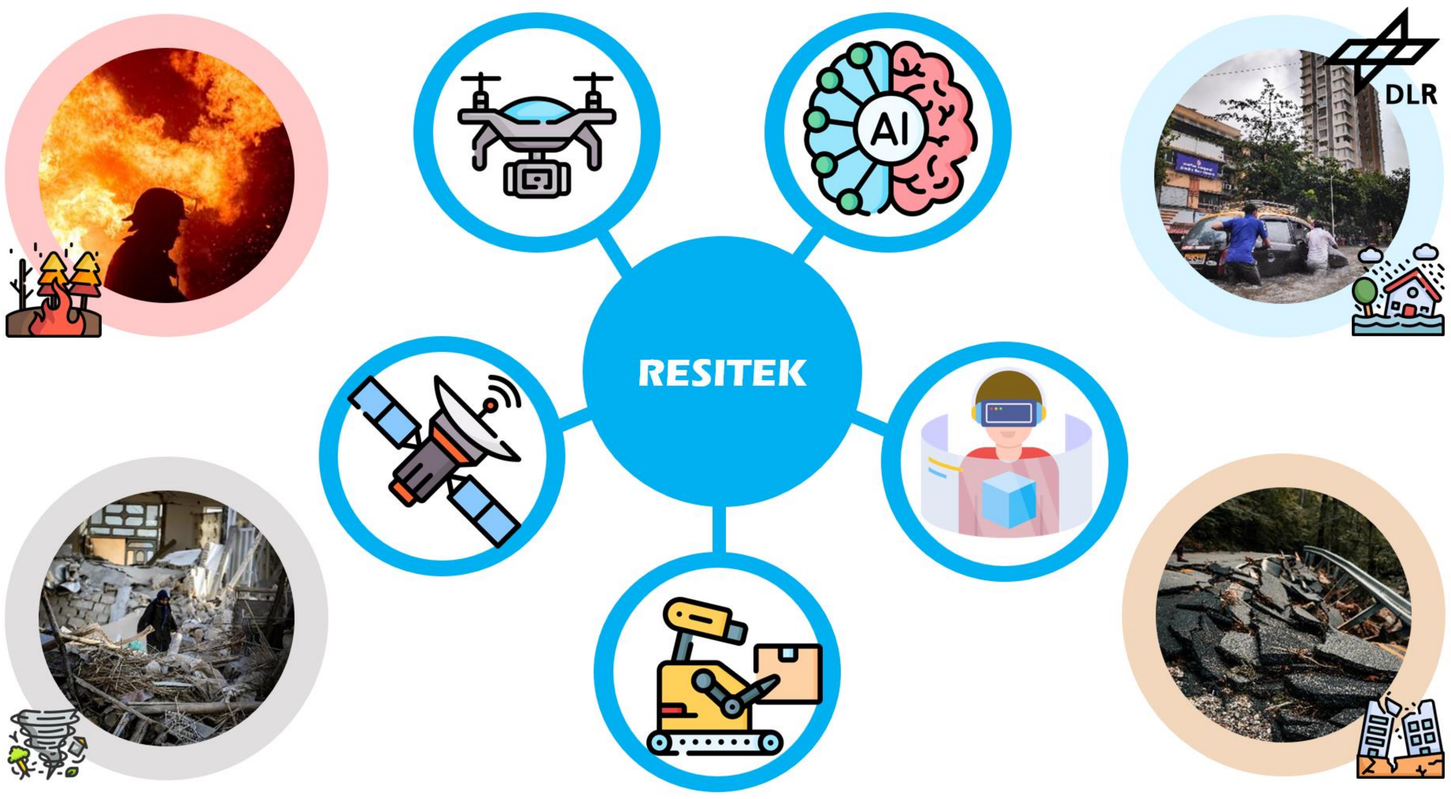

Fig. 1. Integrating technologies across domains in DLR's disaster prevention project *RESITEK*. Technologies include space weather, power grid resilience, remote guidance, mobility, and situational representations – Credits: DLR (visualization), unsplash.com (photos).

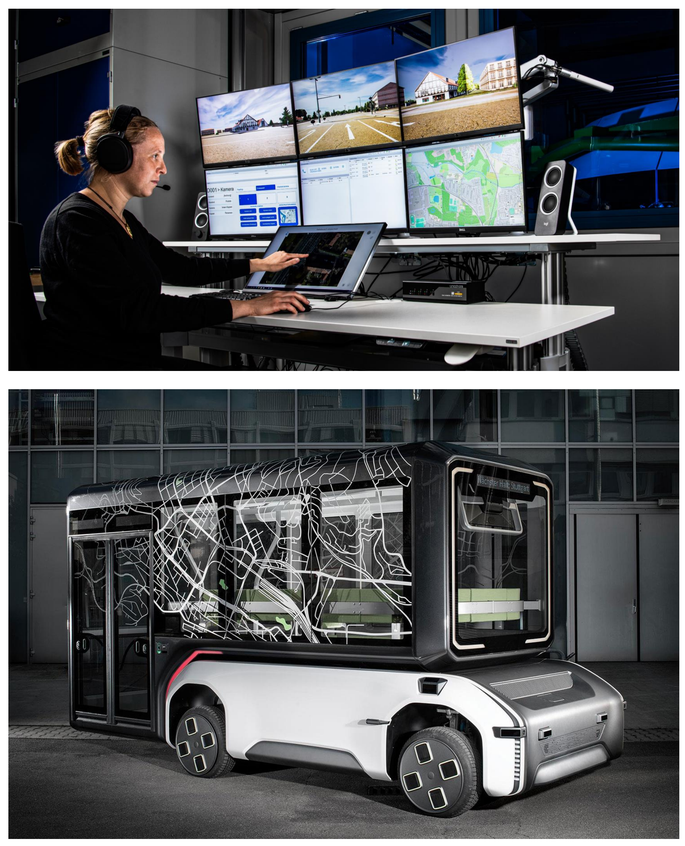

Fig. 2. Providing remote assistance from the remote operator's workplace *(top)* to the HAV U-Shift *(bottom)* – Credits: DLR.

- **Highly automated vehicles** (HAVs, SAE level 4 [2]) could serve as a central component for tackling this challenge. During regular operations, HAVs will operate exclusively within the **operational design domain** (ODD) they are intended for, e.g., to transport passengers on regular roads. However, this ODD might not suffice for the extraordinary challenges occurring in the event of disaster. For instance, an HAV might need to be **repurposed for disaster conditions**, e.g., to operate on road types not covered by the intended ODD.
- One approach to do so is using **remote assistance** technology [3] *(Fig. 2)*. For example, as paved roads may not be usable due to floods, a remote operator could extend the ODD by providing guidance from afar so the vehicle can also use gravel roads outside the ODD, receiving input on the situation via the integrated monitoring system, e.g., on road and weather conditions. In addition, the remote operator could access an HAV's sensors to remotely view the situation around it, remove it from blocking the emergency corridor on highways so emergency vehicles can pass, or even convert it into an emergency vehicle itself.
- Thus, remote assistance technology could contribute to **enhancing resilience of transportation systems in disasters** related to climate change and beyond.

[1] DLR (2025). RESITEK. AI-supported civil protection and disaster prevention. https://www.dlr.de/en/ki/research-transfer/projects/resitek (accessed 24 Feb 2026).
[2] SAE International (2021). *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* (SAE J 3016-202104). SAE. https://doi.org/10.1007/s10111-024-00753-x
[3] Schrank, A., Walocha, F., Brandenburg, S., & Oehl, M. (2024). Human-centered design and evaluation of a workplace for the remote assistance of highly automated vehicles. *Cognition, Technology & Work*. https://doi.org/10.1007/s10111-024-00753-x

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