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Category: Rail

Country: United Kingdom

Research Area 3: Innovative Infrastructure for Europe 2030

Idea Number: 99



T-Vision: A Hybrid Subsurface Radar Inspection System For Intelligent Asset Management of Railway Tunnels

The UK Office of Rail and Road has repeatedly identified that inadequate accuracy and efficiency in hidden critical element detection constitutes one of the main current shortfalls in Network Rail's infrastructure inspection deliverables. Railway tunnel subsurface inspection (RTSSI) to locate the multitude of concealed shafts in historic masonry structures has been particularly problematic for existing market technologies, owing to recurrent limitations of survey dataset incompleteness and extended closure durations - attributed to laborious erection of support structures to probe crown subsurface imagery. However, 3D visualisation is lacking, blind-spots are commonplace and field-of-view realignment is time-consuming. This project addresses identified gaps by developing T-Vision; the first air-launched hybrid rotational- ground penetrating radar assembly for RTSSI. System novelty extends to the deployment of a bespoke single rotating antenna setup that swiftly and accurately returns comprehensive 360-degree subsurface datasets in 3D; and also hybrid raster and helical scanning functionality, capable of generating unique crown-raster imagery and pioneering hackle-helix point cloud datasets of the full tunnel subsurface. To validate technical efficacy of rotational- ground penetrating radar for RTSSI, T-Vision was deployed in Kirton Tunnel (UK). Vertical distortion artifacts identified in raster visuals evidence concealed shaft detection efficacy, whilst the form, versatility, and future innovation pathways for RTSSI hackle-helix point cloud datasets are deconstructed. The hackle-helix point cloud datasets present a viable basis for a future intelligent, virtual infrastructure management platform for Network Rail.

