Case Study

Runway Surface Crack Detection from Aerial Imagery

RUNWAY SURFACE CRACK DETECTION FROM AERIAL IMAGERY IS AN INNOVATIVE AND EFFECTIVE USE OF COMPUTER VISION FOR DETAILED, HIGH-RESOLUTION RUNWAY INSPECTIONS

sequetrics

Surface Scanning for Safe & Efficient Operations

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Summary

Detecting surface cracks on runways using aerial imagery is an intriguing and highly practical use of computer vision and autonomous sensing technologies. It helps airports maintain runway safety by identifying cracks and surface defects early, reducing maintenance costs and preventing accidents.

A project was carried out over 12 months from April 2024 in collaboration with Airborne Research and Innovation in the School of Geosciences, University of Edinburgh, funded by CENSIS's CR&D scheme.

The aim of this collaboration was to develop an advanced solution using ultra-high-resolution (~1 mm GSD) imaging combined with automated detection techniques to inform general surface conditions.

Challenges

Image quality: Differences in resolution, focus, and motion blur due to aerial movement affect detection accuracy.

Crack connectivity: Cracks may be fragmented or intersect with other features, making continuous detection challenging.

Limited labelled data: Manually annotating cracks over large, high-resolution aerial images is time-consuming and costly.

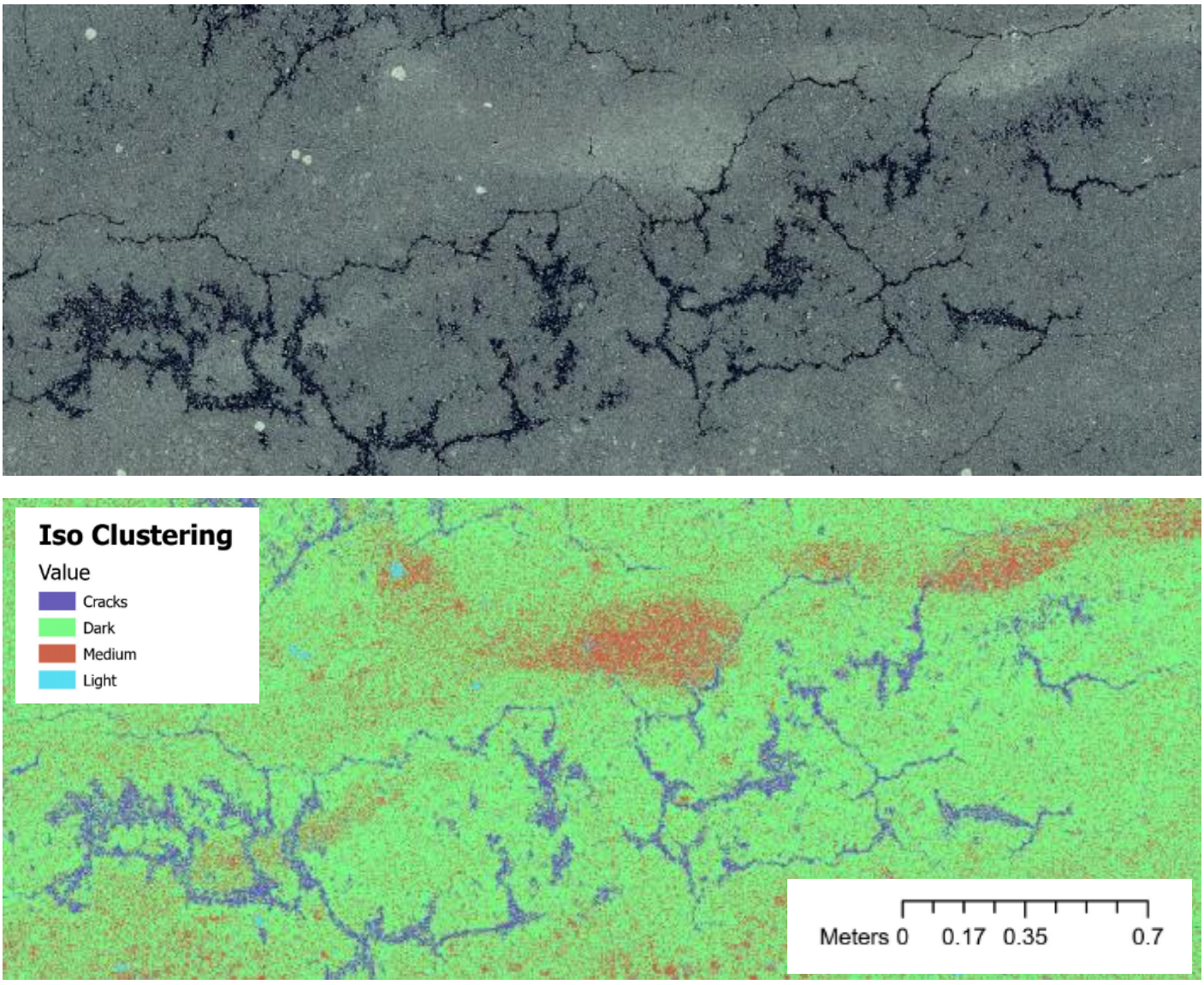
Approach

The approach involved surveying runway surfaced with state of the art in UAV platforms, and imaging cameras, building runway orthomosaics and then splitting these into smaller image blocks, labelling them as containing cracks or not. Our newly developed pipeline and methodology demonstrated effective detection of cracks, offering a robust solution for automated runway crack inspection.

Impact

Our results showcase the potential of utilising ultra-high resolution aerial imagery technology for efficient and accurate runway surface crack detection. Such data streams and their validated outputs can significantly enhance maintenance workflows, ensuring the safety and longevity of airport infrastructures.

Metrics	Manual Baseline Inspection	Aerial Imagery (Sequetrics)	Advantage
Inspection cycle time	Hours (often > 30-60 mins)	**Minutes (often < 15 mins)**	Significantly faster inspections
Surface coverage	Partial (spot checks)	**Full runway surface coverage**	Complete and comprehensive coverage
Detection accuracy	Subjective, operator-dependent	**High precision via automated models**	Improved and consistent accuracy
Personnel required	Multiple inspectors	**Minimal (1-2 operators)**	Reduced labour and cost
Safety	High risk (manual runway access)	**Remote and safe (limited runway closure)**	Enhanced personnel safety
Environmental impact	High (vehicles, equipment)	**Lower (drones)**	Reduced carbon footprint
Data archiving	Limited	**High (easy storage and trend analysis)**	Better long-term maintenance planning
Real-time monitoring	Not feasible	**Possible with UAVs and AI integration**	Faster response to runway issues



Visualisation of a runway pavement using autonomous aerial system and crack analysis (note – the ISO clustering is often used in remote sensing and image processing to segment images into meaningful regions).

Conclusion

Runway surface crack detection using aerial imagery offers significantly faster inspections, reducing cycle times from hours to minutes while providing complete runway coverage compared to traditional spot checks. This approach enhances detection accuracy through automated analysis, reduces personnel needs, and improves safety by minimising runway access. Additionally, it lowers environmental impact with eco-friendly drones and enables better data archiving for long-term maintenance planning.

Collaboration

THE UNIVERSITY of EDINBURGH School of GeoSciences

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Surface Scanning for Safe & Efficient Operations

Collaborative R&D

CENSIS

About Sequetrics Limited

Sequetrics Limited specialises in providing innovative solutions for runway infrastructure inspection and maintenance. Focusing on integrating technology and data analytics, Sequetrics empowers clients to enhance safety, efficiency, and compliance across various sectors.

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