

Meeting Societal Challenges: Big Data-Driven, AI-enabled Approaches

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Our Big Data / AI Research

We focus on addressing societal challenges through fundamental and applied research in Big Data / AI Analytics

- Novel Big Data analytics / AI / Machine (Deep) Learning and Beyond
- Novel Intelligent Architectures (Edge-to-Cloud) facilitating Big Data / AI (running efficiently on High Performance/Parallel and Distributed Computing

Building innovative scalable data products/pipelines across diverse domains(Agriculture, Healthcare, etc.) to address societal Challenges

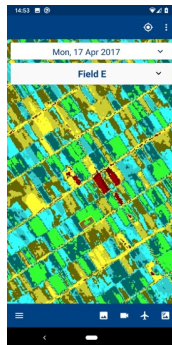
Our Big Data / AI Research

Tackling Societal Challenges



Our Big Data / AI Research

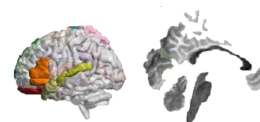
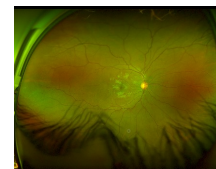
Satellites



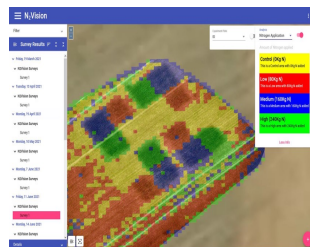
Drones



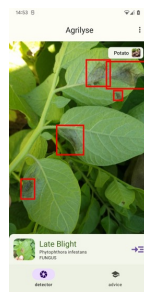
Healthcare



Robotics



Mobile (Edge)



Precision agriculture solutions to address food security and mitigation of GHG emissions (Funded by Newton fund, GCRF, BBSRC, Innovate UK, STFC, British Council. BBSRC-BB/K004077/1, BB/R019983/1, BB/S020969/1) /STFC(ATCNN-PC006&QP003 /Innovate UK- (IUK- 134063,134039 and 104903)).

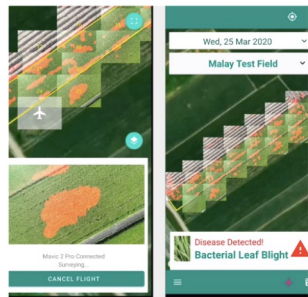
- A Robot enabled data driven machine vision tool for nitrogen diagnosis of arable soil using robotics, image processing, big data/machine learning/AI (<https://n2visionai.wordpress.com>),
 - BBC, Look for East, <https://www.youtube.com/watch?v=cIOWOZ23Tjs>
- Real time mobile on-device crop disease detection using scalable deep learning (<https://epic337255300.wordpress.com>)
- Drone-enabled, big data driven crop disease diagnosis and mapping based on image processing, big data/deep learning, cloud computing (<https://agrigonefarm.wordpress.com>)

AI for Future Farming



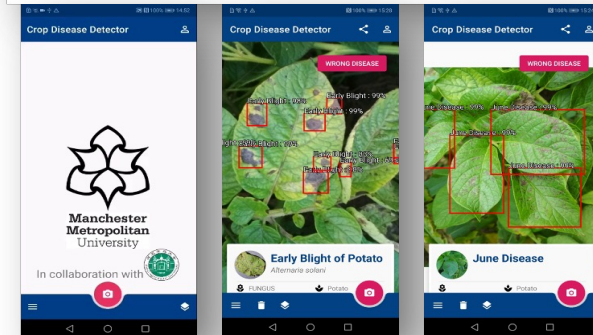
CROP DISEASE DIAGNOSIS USING DRONES

Identifying crop disease using advanced machine learning and big data technology - from large-scale images taken by drones.



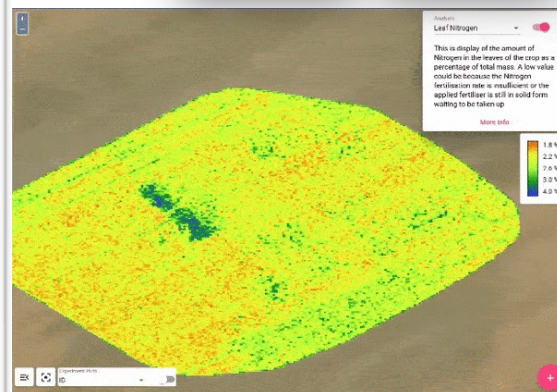
EDGE-AI MOBILE APP FOR CROP DISEASE DETECTION

EPIC uses machine learning and artificial intelligence to perform instant detection of crop disease through a photo-powered app.



RESEARCH: NITROGEN DIAGNOSIS USING AI AND ROBOTICS

N2Vision uses an automated robot to capture data, and machine learning and artificial intelligence to detect nitrogen levels in plants and soils - helping to reduce pollution and protect biodiversity.

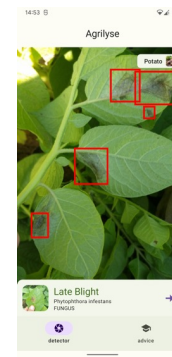
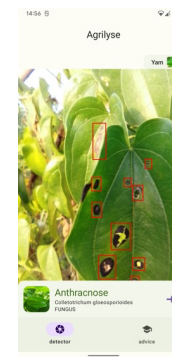
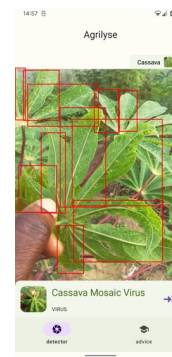
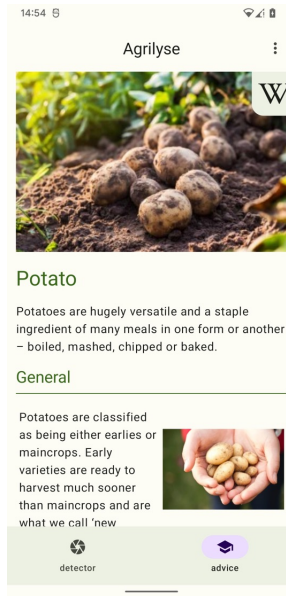
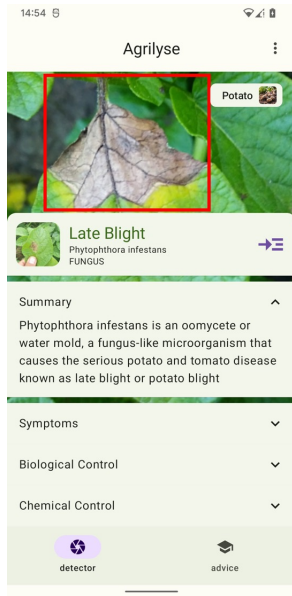
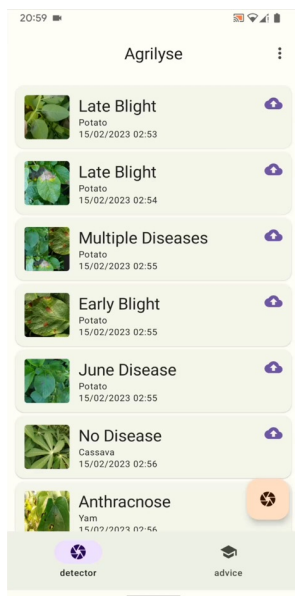




Mobile First On-Device Crop Disease Detection

Our publicly available, modern mobile-first on-device crop disease detection tool has been built around a novel low resource deep learning model capable of detecting and highlighting crop disease in smartphone images

Designed to empower small holders without access to expensive expert analysis, we provide instant up-to data analysis and direct actionable advice to ensure immediate impact, reducing the damage from disease, saving farmers time and money



AgriONE

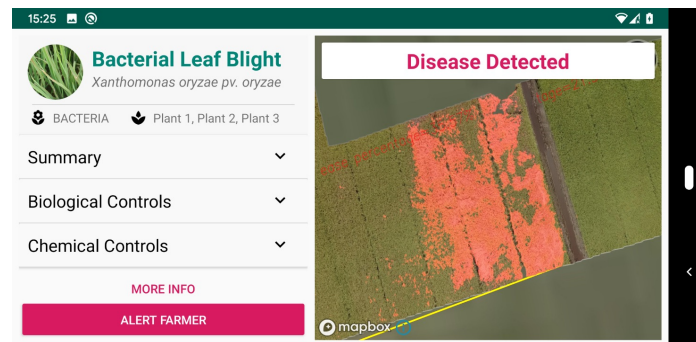


An Unmanned Aerial Vehicle Automatic Crop Disease Diagnosis Tool for Precision Farming

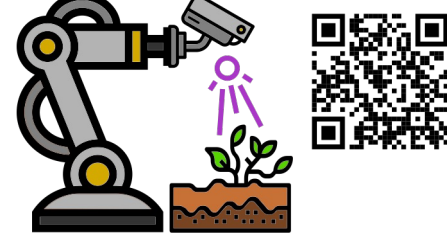
We developed an ICT-based novel automated approach for accurate and timely diagnosis of crop disease (with severity assessment) based on large-scale images taken from an unmanned aerial vehicle (UAV) and smartphones in real fields

Our solution provided intuitive mobile applications capable of automatically flying commercial drones to collect images and provide novel on-device AI analysis to the user in near real-time without any internet access

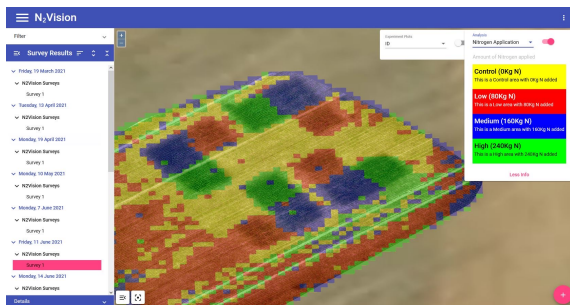
Providing small holders with access to innovative precision agriculture without extensive training and expense, creating real and immediate impact



N₂Vision

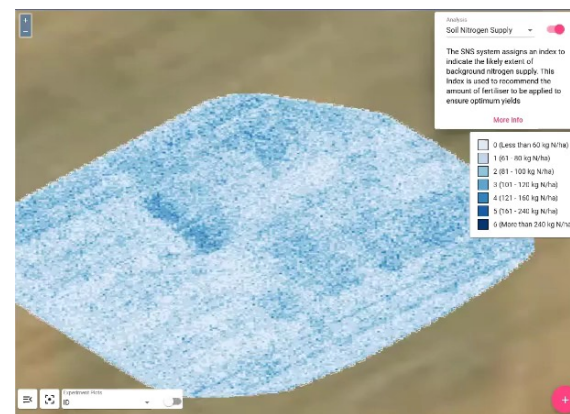
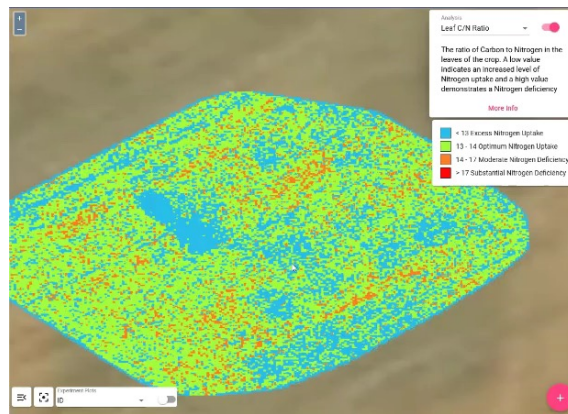
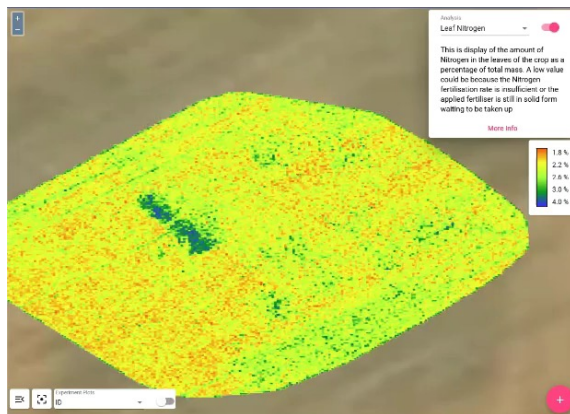


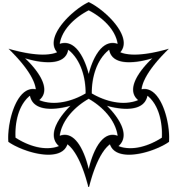
Automated AI driven Nitrogen Diagnosis of Arable Soil



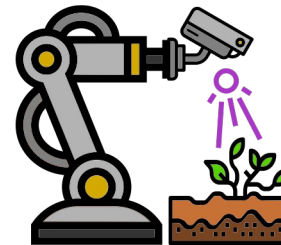
We developed a novel AI analysis using low-cost imagery from Unmanned Aerial/Ground Vehicles capable of providing precision maps of Nitrogen availability in both the crops and soil of arable fields

Created to work with innovative robotic platforms our solution has the potential to transform food production by massively reducing Nitrogen use, saving time and money, while increasing yields and reducing adverse environmental effects





**Manchester
Metropolitan
University**



As Featured On...



itvNEWS



<https://www.youtube.com/watch?v=clOWOZ23Tjs>

Some Selected Publications

- Zhang, X., Han, L. et al. "The Self-Supervised Spectral–Spatial Vision Transformer Network for Accurate Prediction of Wheat Nitrogen Status from UAV Imagery." Remote Sensing 14.6 (2022): 1400.
- Shi Y, Han L, Han L, Chang S, Hu T, Dancey D, " A Latent Encoder Coupled Generative Adversarial Network (LE-GAN) for Efficient Hyperspectral Image Super-resolution" IEEE Transactions on Geoscience and Remote Sensing 1-1 2022, DOI 10.1109/tgrs.2022.3193441
- Shi, Y. Han, L., Huang, W., et al. "A Biologically Interpretable Two-stage Deep Neural Network (BIT-DNN) For Vegetation Recognition From Hyperspectral Imagery". IEEE Transactions on Geoscience and Remote Sensing, 2021, doi: 10.1109/TGRS.2021.3058782
- Zhang, X., Han, L., et al. "How Well Do Deep Learning-Based Methods for Land Cover Classification and Object Detection Perform on a High Resolution Remote Sensing Imagery", Remote Sensing, 2020.
- A Novel CropdocNet for Automated Potato Late Blight Disease Detection from the Unmanned Aerial Vehicle-based Hyperspectral Imagery, <https://arxiv.org/abs/2107.13277>, 2021
- Shi, Y. Han, L., et al. A Latent Encoder Coupled Generative Adversarial Network (LE-GAN) for Efficient Hyperspectral Image Super-resolution, <https://arxiv.org/abs/2111.08685>, 2021
- Zhang, X., Han, L., Dong, Y., Shi, Y., Huang, W., Han, L.H. et al. "A Deep Learning-Based Approach for Automated Yellow Rust Disease Detection from High-Resolution Hyperspectral UAV Images", Remote Sensing. 2019, 11(13), 1554.
- Ma, H., Huang, W., Jing, Y., Yang, C., Han, L. et al "Integrating Growth and Environmental Parameters to Discriminate Powdery Mildew and Aphid of Winter Wheat Using Bi-Temporal Landsat-8 Imagery", Remote Sensing, 2019, 11(7), 846

Product Demos

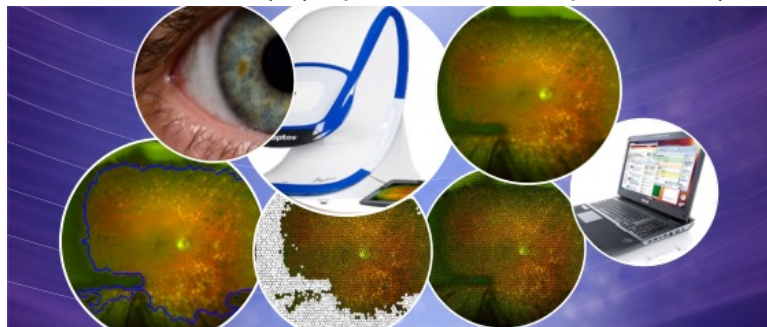
- Future Farming: <https://youtu.be/LGKd5Q4Gaig>
- Agrione: <http://agrione.farm>, <http://agrione.farm/category/product/>, we have developed Drone-enabled big data platform and mobile app to detect rice diseases in real time on field scale. The underlying techniques: big data, machine learning/AI, computer vision, cloud computing, mobile computing.
- EPIC: <https://epic337255300.wordpress.com>, <https://epic337255300.wordpress.com/our-product/>, we have developed mobile app which can detect crop diseases on leaf scale in real time. Mobile machine vision app can run live detection without internet connection.
- Agrilyse (mobile phone for crop disease detection in play store:
<https://play.google.com/store/apps/details?id=uk.co.mmu.tams.agrilyse>

AI for Healthcare

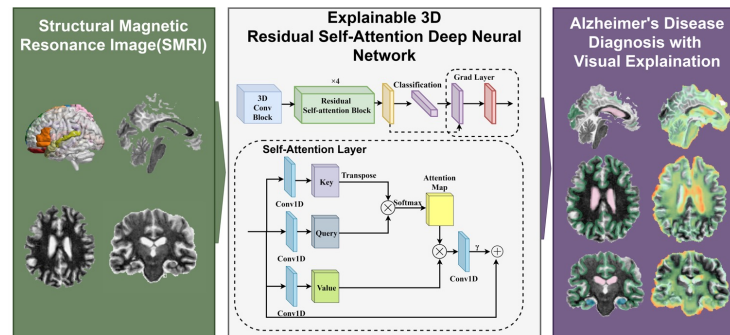
Our strengths and exemplar innovative applications in Big data/Machine Learning/AI (e.g. Agriculture, Healthcare) to address societal challenges.

Healthcare (Scalable machine learning from big data (funded by EPSRC, The Academy of Medical Sciences, Royal Society, Industry))

- Pioneering AI research for computer-aided diagnosis of glaucoma base on novel image processing and machine learning (Funded by EPSRC- Dorothy Hodgkin Award. Also selected as a Finalist of EPSRC ICT Pioneering Competition) (<https://www.youtube.com/watch?v=SnIR-3PWNAw>). In collaboration with industry Optos.
- Pioneering AI research for computer-aided diagnosis of Alzheimer's Disease based on scalable machine learning/deep learning (Newton Advanced fellowship, funded by Royal Society-The Academy of Medical Sciences in collaboration with NUAA) (<https://braidd.wordpress.com>)

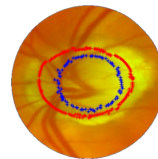


Haleem, S.M., Han, L., van Hemert, J., Li, B., Flemming, A. "Retinal Area Detector from Scanning Laser Ophthalmoscope (SLO) Images for Diagnosing Retinal Disease", IEEE Journal of Biomedical and Health Informatics, 2015 (**Feature Article**)



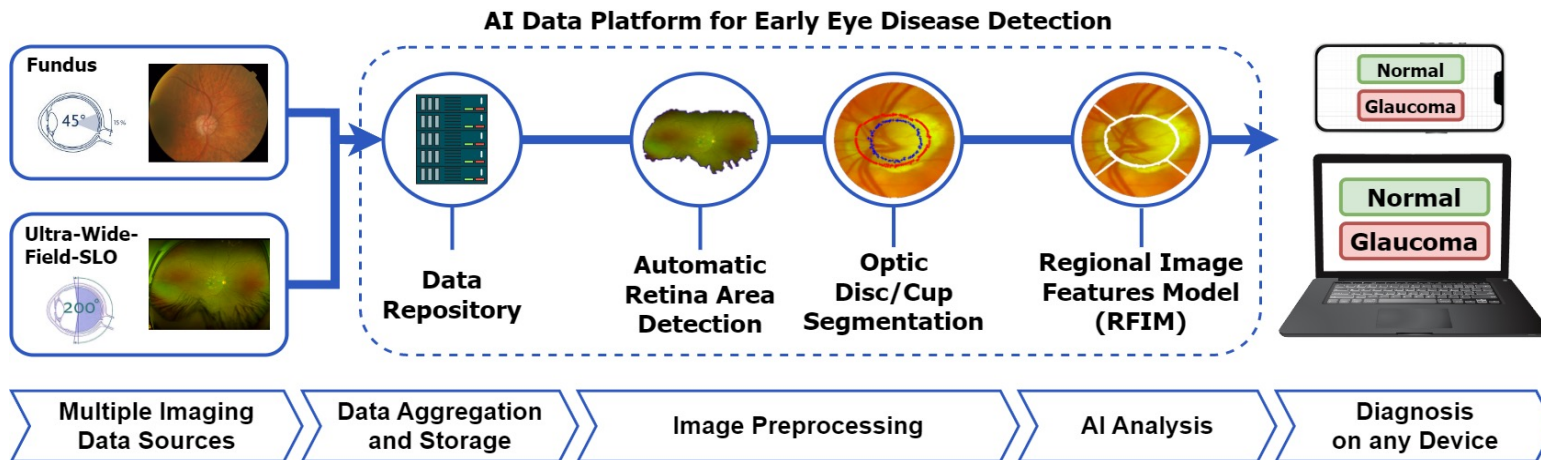
Zhang, X., Han, L. et al. "An Explainable 3D Residual Self-Attention Deep Neural Network for Joint Atrophy Localization and Alzheimer's Disease Diagnosis Using Structural MRI" IEEE Journal of Biomedical and Health Informatics. 26(11): 2022

ADRAI

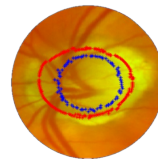


Automatic Detection of Features in Retinal Images to Improve Diagnosis of Eye Disease (EP/J50063X/1)

We developed a series of innovations in AI / Machine Learning creating novel methods to aid in the early diagnosis of eye diseases from multi-modal imagery

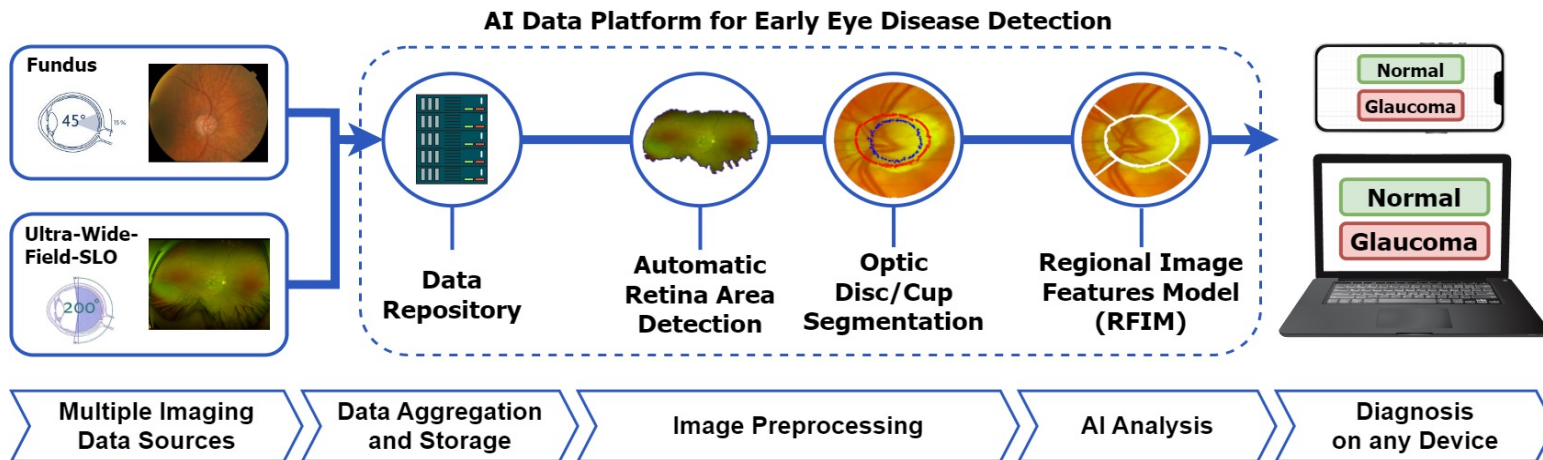


ADRAI



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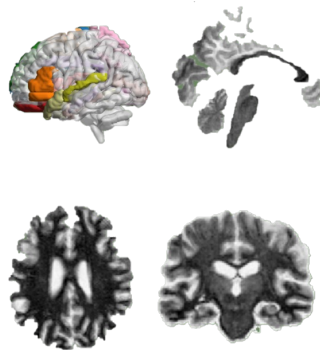


BRAIDD

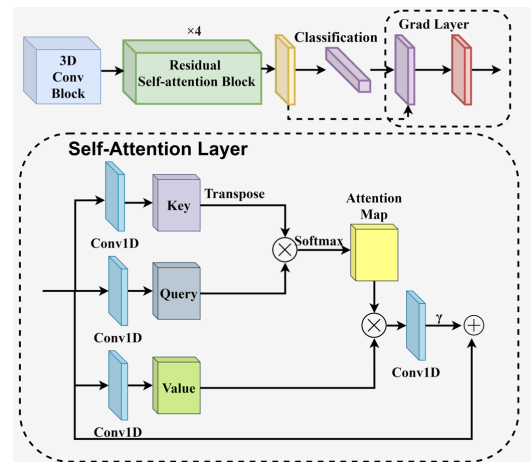


Big-Data Driven Intelligent Analysis of High Dimensional Multimodal Neuroimaging Data and its Application to Brain Disease Diagnosis

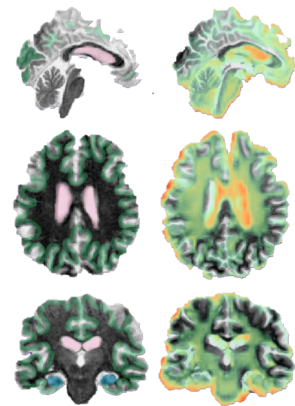
We have developed an innovative explainable 3D residual self-attention deep neural network capable of diagnosing Alzheimer's disease from structural magnetic resonance imagery (SMRI) while simultaneously highlighting the area of the brain responsible for the diagnostician to review



SMRI

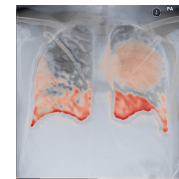


Explainable 3D residual self-attention deep neural network

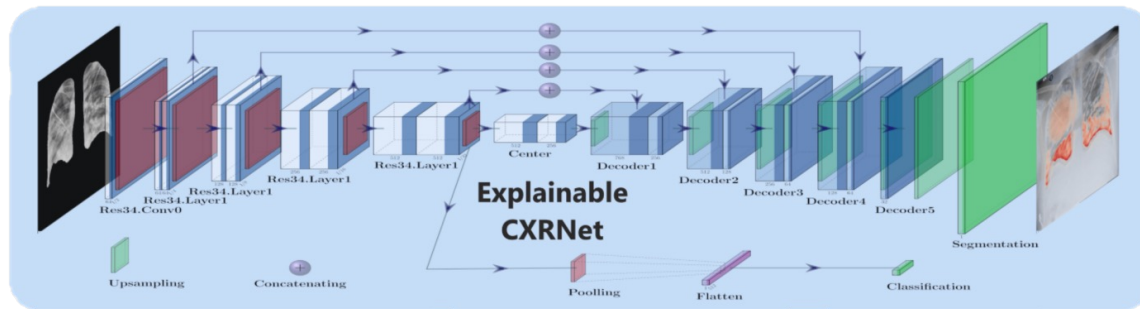


Diagnosis & Explanation

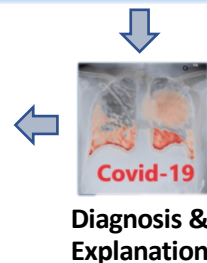
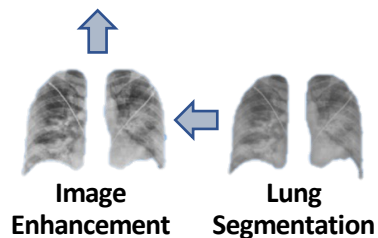
CXRNet



Deep Neural Network for Accurate Explainable Diagnosis of COVID-19 from X-ray Images



We have developed a novel deep learning COVID-19 pneumonia diagnosis tool capable of accurate lung disease classification from X-Ray imagery, while providing radiologists with a visual representation of the area responsible for the diagnosis



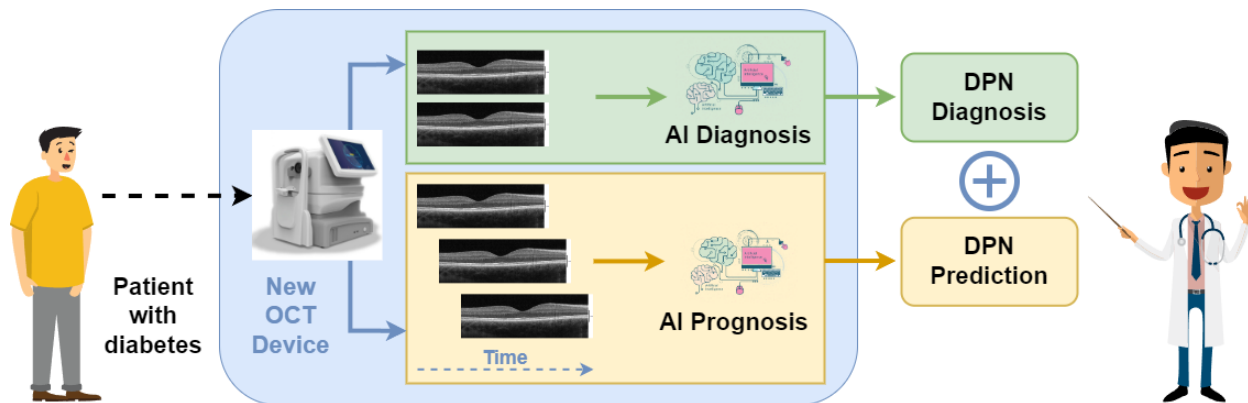
Our assistive tool helps radiographers to screen patients with suspected COVID-19 reducing waiting times for clinical decisions

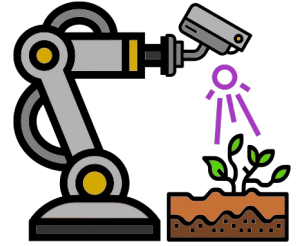
EYE-SCREEN-4-DPN

Development of an innovative Intelligent EYE imaging solution for SCREENing of Diabetic Peripheral Neuropathy (EP/X013707/1, EP/X01441X/1)

Our screening project for diabetic peripheral neuropathy leverages our edge AI and big data analysis to diagnose and predict neuropathy from eye nerve imagery

- To achieve this we have partnered with leading cutting-edge medical imaging producers to help develop a new OCT device with improved definition





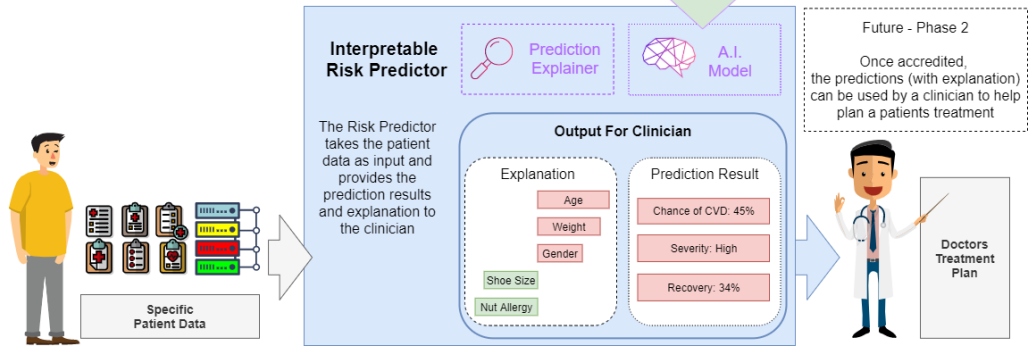
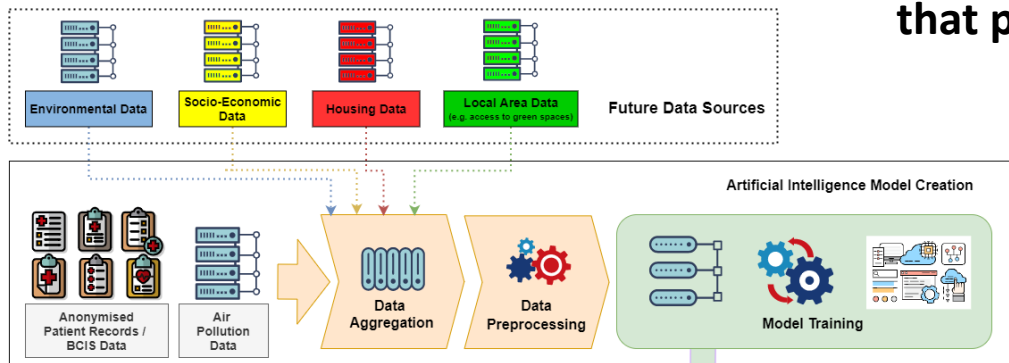
As Featured On...



<https://www.youtube.com/watch?v=kNosRndGK9g>

BHF Cardiovascular Catalyst Award

Using Big Data to identify novel interrelationships that predict incidence of, and recovery from Acute Coronary Syndromes



Are experience in big data analysis has allowed us to create an innovative risk prediction tool for Cardiovascular Health. Providing a clinician with an AI predicted risk report and explanation of how the data indicates the risk

Our Risk Prediction tool will assist clinicians in identifying and planning treatment plans for patients improving their cardiovascular health and alleviating strain on the health service

Some Selected Publications

- Zhang, X., Han, L. Zhu, W., Song, L. and Zhang, D., "An Explainable 3D Residual Self-Attention DeepNeural Network For Joint Atrophy Localization and Alzheimer's Disease Diagnosis using Structural MRI", IEEE Journal of Biomedical and Health Informatics, 2021, doi: 10.1109/JBHI.2021.3066832
- Zhu, W., Sun, L. , J. Huang, Han, L., and Zhang, D., "Dual Attention Multi-Instance Deep Learning for Alzheimer's Disease Diagnosis with Structural MRI" , IEEE Transactions on Medical Imaging, 2021, doi: 10.1109/TMI.2021.3077079
- Akintoye, S. Han, L. et al "A Hybrid Parallelization Approach for Distributed and Scalable Deep Learning", IEEE Access, vol. 10, pp. 77950-77961, 2022, doi: 10.1109/ACCESS.2022.3193690, 2022 <https://arxiv.org/abs/2104.05035>,
- Akintoye, S. Han, L. et al, "Layer-Wise Partitioning and Merging for Efficient and Scalable Deep Learning", Future Computer Generation Systems 2023, <https://arxiv.org/abs/2207.11019>
- Zhang, X., Han, L., et al., "sMRI-PatchNet: A novel explainable patch-based deep learning network for Alzheimer's disease diagnosis and discriminative atrophy localisation with Structural MRI, 2023, IEEE Access <https://arxiv.org/pdf/2302.08967.pdf>
- Zhang, X., Han, L., et al., CXR-Net: A Multitask Deep Learning Network for Explainable and Accurate Diagnosis of COVID-19 Pneumonia From Chest X-Ray Images, IEEE IEEE Journal of Biomedical and Health Informatics, 2023 Feb;27(2):980-991. doi: 10.1109/JBHI.2022.3220813.

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Dr. Yue Shi

Tam Sobeih

Dr. Samson Akintoye

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Selected Partners



Funding

