ISTI Day 2024 - Poster session

A comprehensive system supporting sustainable agricultural production from farm to fork

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Abstract Advancements in Artificial Intelligence (AI) and Computer Vision resulted in significant applications in precision agriculture for high-value crops. However, the full potential of AI is still untapped, particularly in regions with low-income agricultural production, where high-end systems for systematic surveying and treatment are often unaffordable. Our ongoing research focuses on developing accessible computer vision methods that substantially impact the farm-to-fork strategy in view of the United Nations Sustainable Development Goals, especially for "Zero Hunger" [1].

Even though image classification systems have achieved accuracy levels that often surpass human performance – as demonstrated in our previous work [2] – there remain significant challenges and room for improvement. Nonetheless, in the long run, a shift from basic AI-assisted monitoring to more advanced approaches that deliver deeper insights and actionable knowledge is required both from a scientific and applicative standpoint. Can we foresee changes in state after identifying and classifying an object? Can we accurately predict how many plants will reach flowering or fruiting within a specific period, allowing us to match production with demand better, optimise revenue, and minimise food waste? These tasks become particularly complex when dealing with crops planted in open fields and greenhouses located remotely and experiencing varying light, weather, and risk conditions.

An integrated set of methodologies is essential for achieving these goals. First, we need robust techniques to detect and classify plants, distinguishing desired crops from weeds. We also require ongoing monitoring to detect early signs of disease, nutrient deficiencies, stress, or growth anomalies and to take preventive measures when possible. Lastly, tracking and forecasting plant's flowering and fruit ripening stages is needed to optimise harvest timing and yield.

By combining advanced computer vision, mobile computing, remote sensing, and predictive analytics, we aim to create a comprehensive system supporting agricultural production in diverse settings, addressing immediate and long-term challenges.

Hashtags #ComputerVision #AdaptiveEnsemblig #Farm2Fork

REFERENCES

[1] Leadership Council of the Sustainable Development Solutions Network, "Indicators and a Monitoring Framework for the Sustainable Development Goals," 2015, available at https://sustainabledevelopment.un.org/content/documents/2013150612-FINAL-SDSN-Indicator-Report1.pdf. Last retrieved April 29, 2024.

[2] A. Bruno, D. Moroni, R. Dainelli, L. Rocchi, S. Morelli, E. Ferrari, P. Toscano, and M. Martinelli, "Improving plant disease classification by adaptive minimal ensembling," Frontiers in Artificial Intelligence, vol. 5, p. 868926, 2022.

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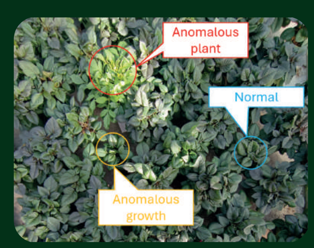
Smart cameras and UAVs for horticulture

WORK IN PROGRESS

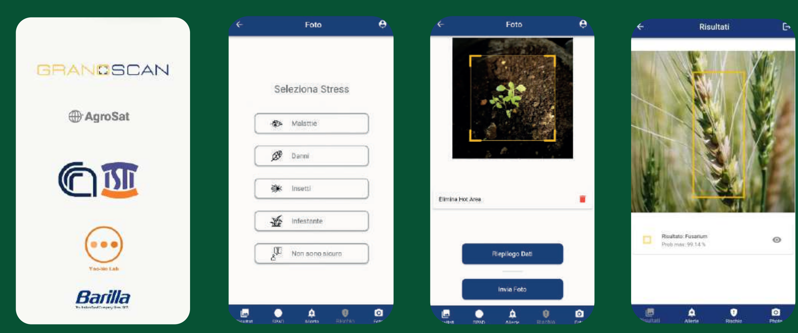
Computer vision and deep learning for:
- weed detection and monitoring
- plant counting
- growth pattern analysis and anomaly detection

Pervasive and distributed solution for large scale indoor/outdoor deployment



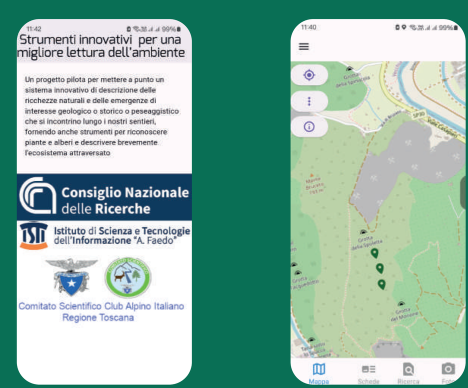
ICT for protecting wheat crops

Artificial intelligent and deep learning for directly supporting farmers in the field



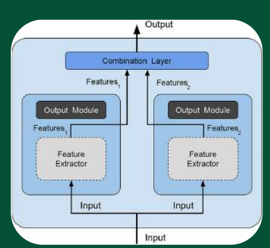
Innovative tools for a better reading of the environment

IT development for deepening and disseminating knowledge in the naturalistic, ecological and botanical fields, useful also for environmental monitoring, in relation to the effects of global warming



Artificial intelligence for recognising plant diseases

An new adaptive esembling approach:
- with superior efficiency
- improving the state-of-the-art in image classification across various domains

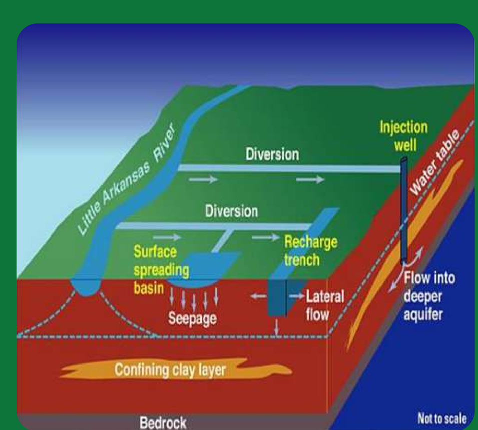


- State of the Art | Image Classification on PlantVillage
- State of the Art | Image Classification on Oxford 102 Flower
- State of the Art | Image Classification on Oxford-IIIT Pets
- State of the Art | Image Classification on Food-101
- State of the Art | Image Classification on CIFAR-10

Hydroinformatics and optimal Artificial Groundwater Recharge (AGR)

Hydroinformatics involves modeling as well as data science methods for the efficient and sustainable use of water resources.
- Optimal planning of areas for performing Artificial Groundwater Recharge (AGR):
  - a practice aimed at increasing the volumes of available groundwater by facilitating its infiltration into the aquifer
  - analysis based on the use of remote sensing and Multi-Criteria Decision Making (MCDM)

Ongoing studies in the Deraa Oued Noun, Gelmim and Massa basins (Morocco)



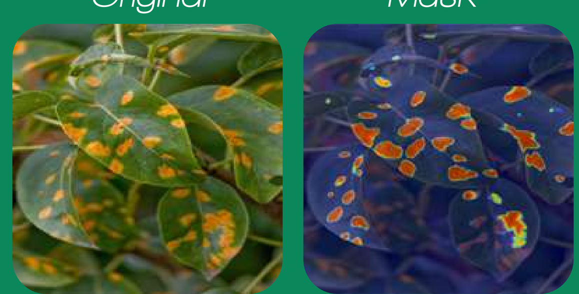
Towards uncertainty-aware segmentation for plant disease

Issues in disease segmentation:
- spotty nature: leaf diseases often have a spotty appearance.
- unclear boundaries: boundaries are not clear, even for human labelers, leading to overestimates and underestimates of affected areas.

To improve accuracy and generalization capabilities, uncertainty can be included:
- devise a loss function incorporating a pixel weighting scheme to express the uncertainty of boundary locations
- experiment performance on a wide range of datasets

Encouraging preliminary results showing better generalization capabilities

Original *Mask*



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