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Boosting Vertical Farming Efficiency: Real Time Monitoring of Plant Health Using Deep Neural Networks

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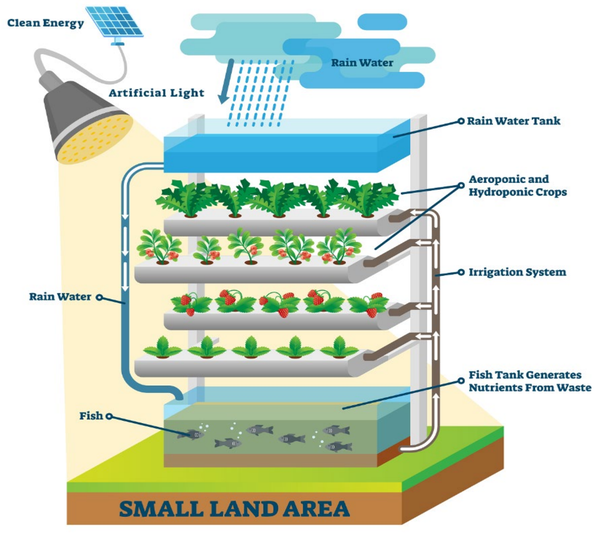
Problem

Vertical Farming Structures (VFS) solve the problem of limited agricultural space in urban areas and inefficient traditional farming. By using vertical layers, VFS maximize space and allow high-density planting in small areas, crucial for densely populated cities. They improve resource efficiency with precise control over light, temperature, and water, reducing water use, pesticides, and boosting crop yields. VFS support sustainable food production and reduce the carbon footprint from long-distance transportation, promoting a resilient and self-sufficient urban food system.

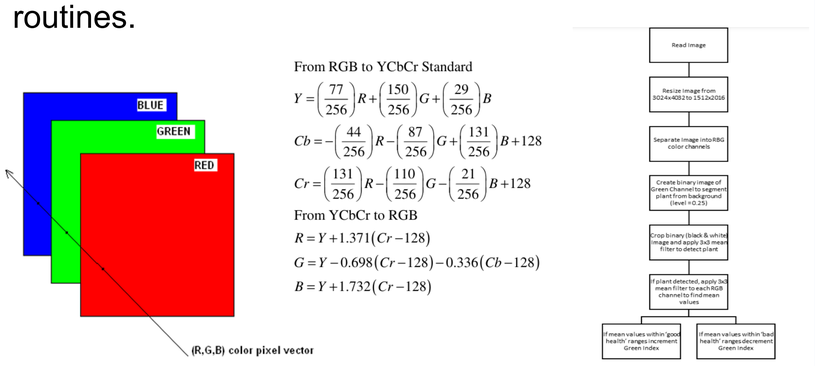


Rationale

Using trained deep neural networks in AI to track leaf health in Vertical Farming Structures (VFS) by observing and analyzing the color images of leaves enables precise, real-time monitoring of plant conditions. This automation improves accuracy in detecting issues like nutrient deficiencies or diseases, allowing immediate adjustments to lighting, water, and nutrients. The result is optimized plant care, increased yield, reduced labor costs, and enhanced scalability.

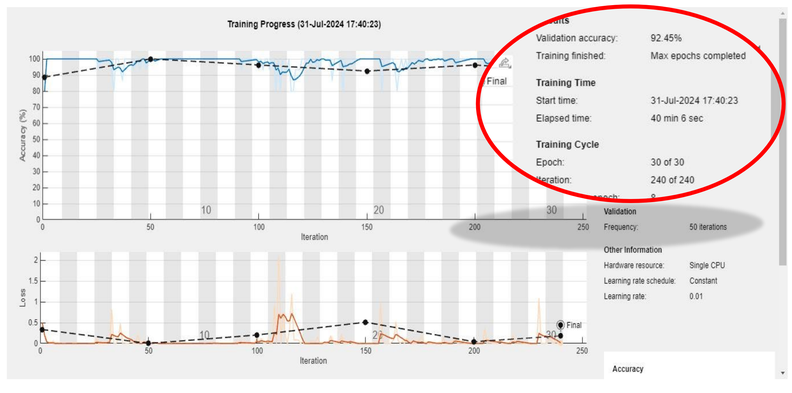
Methodology

Color images have three times as many pixels as grayscale images, requiring more processing power. The most common color image formats are RGB, YCbCr, and HSL. RGB uses three bit-planes for Red, Green, and Blue intensities, while YCbCr uses Y for luminance and Cb and Cr for color differences. MATLAB provides functions to convert between RGB and YCbCr formats with ycbcr2rgb and rgb2ycbcr routines.

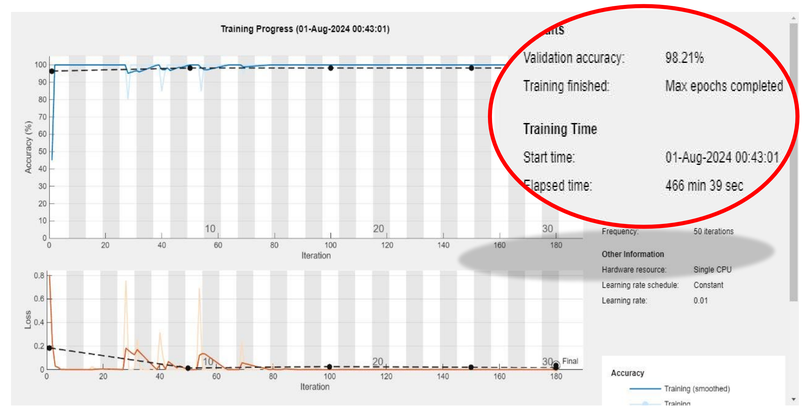


Digital Images are input into the trained DenseNet neural network in Matlab in a formula format shown above that can detect healthy and non healthy leaves.

Data



Deep neural training data for recognition of Healthy Coffee from Leaf Rust Coffee with **92.45%** accuracy from a sample size of 380 images



Deep neural training data for recognition of Healthy from Algal Tea Leaves with **98.21%** accuracy from a sample size of 952 images

Conclusion

In conclusion, our experiment demonstrates that AI can monitor plant health in Vertical Farming Structure (VFS). Further software can adjust lighting, water and temperature in real-time, leading to higher yields and better-quality produce. This approach maximizes space and resource efficiency, providing a sustainable solution for urban food production and security, and has the potential to revolutionize agriculture by making it more resilient and environmentally friendly.

Acknowledgements

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References

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