

Modeling of Plant--Based Life Support Processes  
Using Artificial Neural Networks

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Future regenerative life support systems, in order to provide a significant degree of self-sufficiency for productive research and exploration of space, will rely heavily on crop plants to perform several functions. Plants remove carbon dioxide from the atmosphere and produce oxygen while incorporating carbon into biomass (food) through the process of photosynthesis or assimilation. Water is produced via the process of transpiration. Understanding the dynamic processes associated with assimilation, transpiration, biomass accumulation and allocation, as well as the demands for resources (resources recovered from wastes) is essential to developing and controlling long-term operations of regenerative life support systems.

Artificial neural networks with their ability to learn and approximate arbitrary nonlinear input-output relationships from a collection of examples are very suitable for characterizing these plant-based life support Processes. A neural network architecture has been developed to model transpiration under varying environmental conditions. The neural network model was trained with data from the combination of various mathematical models and the integration of crop histories from controlled environment crop experiments. The performance and the response of the neural network model in interpolating between various conditions and input sensor parameters and the simulation of the complex, nonlinear, dynamic, multivariable transpiration process is demonstrated.