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SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development (3)

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TRAINABLE ANALOG NEURAL NETWORK WITH APPLICATION TO LUNAR IN-SITU RESOURCE UTILIZATION

Abstract

The advent of 3-D printing technology has allowed for the manufacturing of parts, tools, and mechanisms on site, allowing for mission flexibility and cost savings. One particular application of this 3-D printing mission strategy is lunar in-situ resource utilization; the collection and refining of materials available on the moon for the construction of new tools or parts specific to the desired mission. The process may even be extended to the manufacturing of small lunar rovers for automated or supervised exploration. Key components in any device such as a lunar rover are the electronics; typically including components comprised of semiconductors. Due to the complexity of the semiconductor manufacturing processes it is not feasible to have such a manufacturing facility present on the moon and therefore desirable to have an electronics system that can function only with components that can be manufactured in-situ; i.e. without semiconductors. This removes digital electronics, such as microcontrollers, as a viable option and lends to simpler analog, 3-D printable technologies such as resistors, capacitors, inductors and vacuum tubes.

It is possible that a neural network may be constructed solely out of non-semiconductor, analog components. Neural networks can be used for general purpose computing and more specifically control circuits for devices such as rovers. Neural networks are highly versatile and can adapt to new missions and environments through learning processes. A neural network built from analog, non-semiconductor components may be constructed by a lunar in-situ 3-D printing facility.

This paper describes the development and simulation of a non-semiconductor, analog neural network that is trained using an analog adaptation of the back propagation training algorithm. The simulation was conducted using the open source circuit simulation software, SPICE. It is compared to a digital neural network, simulated using MATLAB, and trained using the back propagation algorithm as well as the Kalman filter training method. The implementation of a non-semiconductor, trainable neural network allows for the 3-D printing of electronic control circuits for lunar application.