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Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development (3)

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DEVELOPMENT AND TESTING OF A TRAINABLE ANALOG NEURAL NETWORK ON AN OBSTACLE AVOIDING ROBOT WITH APPLICATION TO LUNAR IN-SITU RESOURCE UTILIZATION

Abstract

Lunar in-situ resource utilization is the gathering and processing of materials found on the moon for the manufacture of new tools specific to a lunar mission. A mission may include the construction of small autonomous lunar rovers for exploration or prospecting. For this mission, the equipment desired to be manufactured includes various electronic components that would typically contain semiconductor parts. The implementation of a semiconductor manufacturing facility is not feasible in a lunar environment as the manufacturing process involves many complex chemical processes. Therefore, it is desired to develop electronics that consist of non-semiconductor components so that they may be manufactured in-situ using a more straightforward process such as 3-D printing. This excludes digital electronic components, such as transistors, from the development of the electronics and includes analog parts that could possibly be manufactured using 3-D printing: resistors, inductors, capacitors, and vacuum tubes.

It was chosen to use neural networks as a foundation for the development of non-semiconductor electronics as they are highly versatile with uses ranging from general computing to simple control systems. This paper describes the development and testing of an analog neural network built with non-semiconductor components for use as an obstacle avoidance system on a small mobile robot. A variation of the backpropagation algorithm modified for use with analog electronics is used for training the network. The ability of the robot to successfully navigate an obstacle field demonstrates the functionality of the developed non-semiconductor electronics leading to the potential use of 3-D printable non-semiconductor electronics in a lunar environment.