Resistors, Fractals and, Infinity - Developing and Exploring Methods for Calculating the Equivalent Resistance of Infinite Networks of Resistors

Abordi, Joshua (School: Mount Lawley Senior High School)

In this project the intricacies of continued fractions are explored by extending them (through use of recursion) to infinity whilst applying them to the context of repeating arrangements of resistors. The algebraic operation of infinite continued fractions, when applied to networks of resistors, shows great promise for being useful tools in furthering understanding of networks found in fields such as irrigation, antenna design, and power distribution. The focus of this project was a method for calculating the resistance between two nodes on infinite towers of resistors using the algebraic concept of infinite continued fractions. These continued fractions were constructed using a recursive definition that can be applied when the number of elements (resistors) in these towers are limited to infinity. Whilst no solution to the initial problem of resistors in infinite grids was found, the techniques developed were able to provide bounds for equivalent resistances of such arrangements. As recursion was already present, applying these methods to a novel fractal arrangement of resistors (similar to the H tree Fractal) was entirely possible, with a negligible increase in difficulty when solving algebraically compared to infinite towers. A number of novel methods for the representation of structures of resistors (both infinite and finite) were also developed, including a method involving the novel concept of recursive adjacency matrices. As the methods developed are simpler than existing solutions that use differential equations or the superposition theorem (an extension of Kirchhoff's laws) these techniques may be more readily applied to real world issues.