F21   Using Fractal Dimension to Classify Human Dentitions

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After attending this presentation, attendees will understand the concept of fractal dimension and to comprehend how a box counting algorithm can approximate the fractal dimension of an image. At the completion of the lecture participants will appreciate that a human anterior dentition can be described mathematically and classified as to its uniqueness.

This presentation will impact the forensic science community by making an easy to implement method, to describe and classify the teeth used in a bite mark analysis, available.

Bite mark analysis has been criticized for its lack of scientific basis and mathematical foundation. This study makes available to the forensic community an easy to implement method to describe and classify the teeth used in a bite mark analysis.

This study was undertaken to determine if the fractal dimension of an image of a human anterior dentition could be used to describe and classify the dentition. Images of ten dentitions were available for study. The upper and lower arches were separated from the initial images to produce 20 working images. The working images were manipulated in GIMP 2.6.4 (GNU Image Manipulation Program) to yield an occlusal view of the outline of the facial surfaces of the six anterior teeth. The images of the outlines of the facial surfaces were analyzed by two different box counting programs to calculate the fractal dimension of each image. The box counting programs were ImageJ 1.42q, a freeware program from the National Institutes of Health and a proprietary program written in Microsoft C#.

Fractals are natural phenomena in which a structure is composed of parts that are similar in shape to the whole. The shape of the parts remains the same as the scale is changed when the viewpoint is zoomed in. This is called self-similarity. The facial outline of human anterior

human dentition of either arch is convex in shape and composed of convex shaped teeth, which are composed of convex shaped developmental ridges, which are formed from convex shaped enamel rods. The fractal dimension is a statistical quantity that gives an indication of how completely a fractal appears to fill space. In a box counting procedure smaller and smaller grids are placed over the curve. The number of times the curve crosses a grid box is summed for each different scale. The fractal dimension is approximated form the changes in box counts at the different scales.

A regression formula was developed that allowed classification of the images as either common or unique.

The dentitions depicted in the initial images were divided by forensic dentists into two groups; either normal alignment or malalignment of the teeth.

This study has shown that there is a positive correlation between use of a box counting algorithm to classify dentitions and the ability of trained forensic dentists to discriminate alignment features of a dentition.

This study is an initial feasibility study into the use of fractal dimension as a tool for the forensic odontologist. It is hoped that future studies will yield a scientifically valid method to evaluate the evidentiary value of an individual dentition.

Bite Mark Analysis, Odontology, Fractal