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Chapter V

Concepts of Emergence Index in Image Databases

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Emergence is a phenomenon where we study the implicit or hidden meaning of an image. We introduce this concept in image database access and retrieval of images using this as an index for retrieval. This would give an entirely different search outcome than ordinary than search where emergence is not considered, as consideration of hidden meanings could change the index of search. We discuss emergence, emergence index and approach how to apply this concept in image retrieval in this chapter.

INTRODUCTION

Images are generated all over from various sources. It could be satellite pictures, biomedical, scientific, entertainment, sports and many more. Content-based image retrieval (CBIR) is being applied to access these vast volumes of images in databases. Some of the areas where CBIR is applied are weather forecasting, scientific database management, art galleries, law enforcement, and fashion design.

Initially image representation was based on attributes and was accessed using those attributes. Also there was a feature-based object-recognition approach where the process was automated to extract images based on features and objects.

Recently combining these two approaches, efficient image representation and query-processing algorithms have been developed to access image databases.

Most of the work done so far is based on only the analysis of explicit meanings of images. But image has implicit meanings as well which give more and different meanings than only explicit analysis provides. In this chapter we provide the concepts of emergence index and analysis of the implicit meanings of the image which we believe should be taken into account in analysis of images of image or multimedia databases.

This chapter appears in the book, Distributed Multimedia Databases: Techniques and Applications by Timothy K. Shih.

BACKGROUND

Emergence Index

A feature of an image that is not explicit would be an emergent feature if it can be made explicit. There are three types of emergence: computational emergence, thermodynamic emergence and emergence relative to a model (Cariani,1992). In computational emergence, it is assumed computational interactions can generate different features or behaviors (Forrest,1991;Langton,1989). This is one of the approaches in the field of artificial life. Thermodynamic emergence is of the view that new stable features or behaviors can arise from equilibrium through the use of thermodynamic theory. In emergence relative to a model, deviation of the behavior from the original model gives rise to emergence. We will use this latter view in our chapter.

In computational emergence, new shapes or images develop but within certain limits as programmed by the computer programmers. No new shape can emerge beyond the logic of the program.

In thermodynamic emergence, emergence can be defined as emergence of order from noise. Stochastic processes at micro-level form discrete macro-level structures or behaviors. The example of this type of emergence is gas where stochastic movements of atoms or molecules within the gas creates the ordered properties of temperature, pressure and volume at a higher level.

An example of emergence relative to a model is where changes in internal structure and consequently in its behavior occur and we as observers will need to change our model to track the device's behavior in order to successfully continue to predict actions.

Whenever we shift our focus on an existing shape – in other words, an image, a new shape emerges. The representation of the new shape is based upon view of the original shape. The new shape emerges as we change our view of the original shape. This is the fundamentally most important idea of emergence.

Two classes of shape emergence have been identified: embedded shape emergence and illusory shape emergence. In embedded shape emergence, all the emergent shapes can be identified by set theory kind of procedures on the original shape under consideration. For example, in a set S= {a,b,c,d,e}, we can find subsets like S1={a,b,c}, S2={c,d,e}, S3={a,c,e}, and so on. But in illusory shape emergence, where contours defining a shape are perceived even though no contours are physically present, this kind of set theory procedures is not enough and more effective procedures have to be applied to find these hidden shapes (Gero and Maher,1994; Gero,Year Unknown). These procedures could be based on geometrical, topological or dimensional studies of the original shape.

Structure, Behavior and Function of Emergence

Structure of a shape is the physical definition of the shape. For example, a box could be rectangular in shape. Its length, width and height, as well as color, and substance (like wood, metal or hard paper) would define the structure of the shape. Behavior of the box could be to contain certain items in it and the function could be to carry items from one place to another using the box as a container, which is the purpose for which the box is used. Emergence of new structure, behavior or function takes place when these descriptions are interpreted in ways not anticipated in the original description (Gero and Maher,1994) .