Electronic Roads in the Information Society

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The objective of this study is to investigate an approach for dynamic construction of Electronic Roads. We envision Electronic Roads spanning a virtual multidimensional space, a distributed digital information repository, comprising primarily of video data of cultural heritage. A visitor (user) will be able to travel in this multidimensional space along different, semantically related historical, geographical, economic or cultural paths.

Consider the following example. At a particular point in time our visitor (user) is located at a node of this multidimensional space and s/he has to decide how to proceed with his/her journey. A cluster of nearest neighbours is computed and presented to the user based on the current node but also the most recently visited nodes in order to postulate as to which semantic path the visitor is actually following. Even though the *next* node along this path has precedence the user will have the option to override this, thus migrating to a different path.

The building block of the system is the *information unit,* which consists of the actual data (e.g. segment of video, image, sound or text) with an attached metadata index. All information units are elementary in granularity. That is, there is no hierarchical structure. The repository of information can be viewed as a pool of information units. There is of course a tradeoff as to what will be precisely the level of granularity, i.e. how elementary the information units will be. The more elementary the information units are the more flexibility the system has to adapt dynamically to the user needs, but of course the overall set of activities incur more overhead. On the other hand, the more coarse grain the information units are the easier it is to retrieve them and combine them but flexibility is limited.

The structure of the *metadata index* is central to the system design. The metadata index would therefore consist of four principal entries one for each subspace.

1. The date the information unit refers to.
2. The (x, y, z) coordinate the information unit refers to.

C. Nikolaou, C. Stephanidis (Eds.): ECDL'98, LNCS 1513, pp. 689–690, 1998.
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3. The location of the information unit in the Economy space.
4. The location of the information unit in the Cultural space.

In addition the metadata index contains data about media type (e.g. voice, video, text), size, location (e.g. IP address), and quality of service considerations (e.g. real-time, loss tolerant).

Information units are combined to form composite *knowledge units*. These knowledge units are the nodes in the traveler's path. The composite knowledge units themselves contain an *knowledge unit index* which is produced from the fusion of the indexes of the underlying information units. In essence each entry in this index pin-points the exact location of the attached data/pointers to information units along the path the entry corresponds to. An example could illustrate the case better.

Assume that we have a virtual space with information units that refer to the cultural heritage of the island of Cyprus. One could navigate (travel) through this space along many directions but for now let us assume there are only four subspaces.

1. Historical/Chronological Path.
2. Geographical/Topological Path.
3. Path through the Economy.
4. Path through Culture.

A *coordination agent* now based on a user "query" and taking into consideration the network and the user profiles, locates several of the elementary information units, composes them into a knowledge unit, and presents this to the user as the result of the "query". The "query" itself could be replaced by the instruction of the user to move to the next node in order to tie this paradigm to the notion of a journey.

The construction of the Electronic Road is made possible by the calculation of the nearest neighbors of the knowledge unit. The nearest neighbors can be computed from the knowledge unit indexes since their entries correspond to the location of each knowledge unit in the particular subspace. Currently the Euclidean distance is the metric used although more complicated evaluation methods are investigated. If we confine the traveler to travel only in one subspace, the only metric relevant is the metric of the subspace itself. On the other hand if we allow the traveler to cross subspace boundaries it means that the distance metric will be a weighted sum of the metrics in each subspace with the weights summing up to 1. The idea is that the higher the relevance of the subspace to the trip the higher the weight.

A thematic prototype for the cultural heritage of Cyprus encompassing the system architecture of Electronic Roads introduced in this work is currently being developed.