EXPLORATION OF MULTIMEDIA CONTENT : AN ONTOLOGY BASED APPROACH

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Certificate

This is to certify that the thesis titled **Exploration of Multimedia Content: an Ontology Based Approach** being submitted by Anupama Mallik to the Department of Electrical Engineering, Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy, is a record of bona-fide research work carried out by her under my guidance and supervision. In my opinion, the thesis has reached the standards fulfilling the requirements of the regulations relating to the degree.

The results contained in this thesis have not been submitted to any other university or institute for the award of any degree or diploma.

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Abstract

This thesis proposes an ontology-based framework for the exploration and management of a domain-specific multimedia collection with flexible structure and dynamic updation. Multimedia collections of digital resources belonging to a domain contain digital replicas of the objects or events which relate to that domain. But an important component of a multimedia collection is the contextual knowledge relating to the data files which puts each resource in its correct perspective. Our framework is motivated by the need for relating the digital objects with contextual knowledge, in order to present them to the user in a correlated form, thus making them more usable.

The ontology-based framework provides a concept-driven, content-based multi-modal retrieval scheme for diverse multimedia collections. The framework supports a user-friendly query interface which allows the users to express their information need in terms of a textual query. The natural language query is mapped to a semantic concept, in order to correctly interpret the media related intent of the user query. The semantic concepts can be interpreted in terms of a set of observable media pattern specifications with collection-independent domain knowledge provided by the ontology. To support this perceptual modeling of concepts, a unique multimedia representation scheme is introduced in the thesis.

We present the formalisation of a new ontology representation language Multimedia Web Ontology Language (MOWL) for multimedia data processing. Besides encoding the knowledge of the concepts and relations in a domain, the language can be used to formally express the association between observable media properties and the concepts. The language also provides a mechanism for formal definition of spatio-temporal relations that exist between objects and events in temporal media. The formalism of the language enables

reasoning with the media properties of the concepts. We follow a causal model, where we assume that the conceptual real world elements cause specific media patterns to manifest in the multimedia documents. Following the premise of abductive reasoning, a concept can therefore be recognized by the evidential strength of the observed media patterns. We have proposed a Bayesian Network based probabilistic reasoning scheme with MOWL to cope up with inherent uncertainties associated with the observation of the expected media features in different media instances representing embodiment of domain concepts.

We propose an ontology learning scheme in the thesis which combines standard multimedia analysis techniques with knowledge drawn from conceptual meta-data to learn a domain-specific multimedia ontology from a set of annotated examples. A standard machine learning algorithm that learns structure and parameters of a Bayesian Network is extended to include media observables in the learning. An expert group provides domain knowledge to construct a basic ontology of the domain as well as to annotate a set of training videos. We construct a more robust and refined version of this ontology by learning from this set of conceptually annotated data. In an interesting application of multimedia ontology learning, we have shown personalization of video search by learning the ontology from implicit user feedback.

We use the ontology specified knowledge built by our framework, for recognizing concepts relevant to a multimedia document to annotate fresh additions to the multimedia collection. The attachment of conceptual annotations to multimedia content helps to index a collection and thus improves retrieval of data from it. This meta-data association is semi-automatic and is similar to a curating process, but it is content-based and thus far outweighs the laborious and subjective manual process of annotating data. Our framework with its unique concept-recognition faculty has the capability of correlating the digital resources in different collections, which pertain to the same concept in the ontology. Once a digital multimedia collection has been curated and annotated at different levels of granularity with semantic concepts of its domain, it is possible to provide a semantic access its constituent media files using the MOWL encoded domain ontology. We have developed a video browsing application with an ontology-guided navigational interface to browse a domain-specific video collection We show an application of our ontology-based framework

for exploration of multimedia content, in the field of heritage preservation. By constructing an ontology for the cultural heritage domain of Indian Classical Dance, and by offering a browsing application for semantic access to the heritage collection of Indian dance videos, we demonstrate the efficacy of our approach.

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