

AN ONTOLOGY GUIDED FRAMEWORK FOR MULTIMEDIA CONTENT ANNOTATION

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AN ONTOLOGY GUIDED FRAMEWORK FOR MULTIMEDIA CONTENT ANNOTATION

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Certificate

This is to certify that the thesis titled “**An Ontology-guided Framework for Multimedia Content Annotation**” being submitted by **Ms. Nisha Pahal** to the Bharti School of Telecommunication Technology and Management, 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 our 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 the degree or diploma.

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Abstract

This thesis proposes an ontology guided framework for annotating multimedia content. The annotation scheme is based upon a model of events and facilitates discovery and exploration of media content in a novel fashion. We examine the problem of multimedia content analysis to automatically detect the event related aspects from the large collection of multimedia data scattered over the web. The related conditions that enables an event to occur can be viewed as the context of an event. The context gets defined with respect to an event instance where the event context has its own structure and it involves spatial, temporal and agent/ entity related aspects. Our annotation framework aggregates contextually relevant documents from the web to assist users in different kinds of retrieval tasks. In this thesis we have presented:

1. Formalisation of a new Multimedia Web Ontology Language (E-MOWL) to handle events with media depictions. The temporal, spatial and entity aspects that are implicitly linked to an event are represented through this language to model temporal and geographical context of events. Apart from encoding the knowledge of concepts and relations in a specific domain, the language can be used to formally express the association between the various concepts and event related aspects. The formalism of the language enables reasoning with the uncertainty associated with the events and is organized in the form of Bayesian Network (BN). The observed evidences are mapped onto the BN and subsequently

the posterior probabilities are calculated to detect the presence of a higher-level event. Uncertainty reasoning allows to exploit the knowledge in the ontology for the purpose of drawing an inference.

2. The ontology-driven framework to design an unsupervised concept-driven multimedia tagging scheme that assigns contextual and expressive tags to a query video. The most important aspect of our endeavour is the automatic identification of context information from multimedia data. The context information associated with an event ties the audiovisual data with its temporal, spatial and entity related aspects. All these aspects when considered altogether provide the evidence and contribute towards recognizing an event from multimedia documents.

We have designed and implemented an ontology-guided multimedia tagging application that provides a comprehensive base for tagging multimedia content on the basis of context information. The document corpus has been formed automatically by utilizing the context information so as to assimilate semantically aligned documents from diverse web sources. This is subsequently used for identifying the conceptual evolution of event patterns temporally as well as spatially. To trace the conceptual evolution of events over time, Temporal Trend Analysis has been utilized. It makes use of statistical topic modeling and topic-to-concept mapping approaches to associate a conceptual tag to topics over time. To track the emergence of event patterns over space, Geographical Trend Analysis has been used. For this, geo-spatial knowledge has been exploited wherein, the geographical named entities are mapped onto the ontology concepts to identify the evolution of event patterns spatially. We have demonstrated the efficacy of our approach by constructing an ontology for the News Domain

and by offering various applications like tagging and trend analysis for thematic linking of documents dispersed over the web along with providing the temporal and geographical trends.

सार

इस थीसिस ने एनोटेटिंग के लिए एक आन्टोलॉजी मार्गदर्शित रूपरेखा का प्रस्ताव किया है मल्टीमीडिया सामग्री। एनोटेेशन योजना पर आधारित है घटनाओं का एक मॉडल और की खोज और अन्वेषण की सुविधा एक उपन्यास फैशन में मीडिया सामग्री। हम इस समस्या की जांच करते हैं मल्टीमीडिया सामग्री विश्लेषण को स्वचालित रूप से ईवेंट का पता लगाता है मल्टीमीडिया डेटा के बड़े संग्रह से संबंधित पहलुओं को बिखरे हुए वेब पर। संबंधित स्थितियां जो एक ईवेंट को सक्षम करती हैं होने के लिए एक घटना के संदर्भ के रूप में देखा जा सकता है। प्रसंग एक घटना के उदाहरण के संबंध में, जहां कार्यक्रम आयोजित किया जाता है संदर्भ की अपनी संरचना है और इसमें स्थानिक, लौकिक शामिल है और एजेंट / संस्था संबंधित पहलुओं। हमारे एनोटेेशन फ्रेमवर्क समुच्चय वेब से प्रासंगिक प्रासंगिक दस्तावेजों की मदद के लिए प्रयोक्ता के लिए पुनर्प्राप्ति कार्य के प्रकार। इस थीसिस में हमारे पास है प्रस्तुत किया:

- एक नई मल्टीमीडिया वेब ओटोलोजी भाषा का औपचारिकरण (ई-MOWL) मीडिया के चित्रणों के साथ घटनाओं को संभालने के लिए। अस्थायी, स्थानिक और संस्था के पहलुओं जो सम्पूर्ण रूप से जुड़े हुए हैं एक घटना के लिए मॉडल के लिए इस भाषा के माध्यम से प्रतिनिधित्व कर रहे हैं घटनाओं का अस्थायी और भौगोलिक संदर्भ। इसके अलावा एक विशेष डोमेन में अवधारणाओं और संबंधों के ज्ञान को एन्कोडिंग, भाषा को औपचारिक रूप से व्यक्त करने के लिए इस्तेमाल किया जा सकता है संबंधित विभिन्न अवधारणाओं और घटना के बीच संबंध पहलुओं। भाषा की औपचारिकता तर्क को सक्षम करती है घटनाओं से जुड़े अनिश्चितता के साथ और बायेसियन नेटवर्क (बी एन) के रूप में आयोजित किया जाता है। मनाया गया साक्ष्य बीएन पर मैप किए जाते हैं और बाद में पिछली संभावनाओं की उपस्थिति का पता लगाने के लिए गणना की जाती है एक उच्च स्तरीय घटना का। अनिश्चितता तर्क की अनुमति देता है के उद्देश्य के लिए ओण्टोलॉजी में ज्ञान का फायदा उठाने के लिए एक निष्कर्ष ड्राइंग।
- एक अनसॉर्ड डिजाइन करने के लिए आन्टोलॉजी आधारित ढांचे अवधारणा-आधारित मल्टीमीडिया टैगिंग योजना जो प्रासंगिक प्रदान करती है और एक प्रश्न वीडियो में अभिव्यंजक टैग। सबसे अधिक हमारे प्रयास का महत्वपूर्ण पहलू है स्वचालित पहचान-मल्टीमीडिया डेटा से संदर्भ जानकारी का निर्माण। एक घटना से संबंधित संदर्भ जानकारी ऑडियो-विज्ञान से जुड़ी है अपने अस्थायी, स्थानिक और संस्था संबंधित पहलुओं के साथ डेटा। इन सभी पहलुओं को पूरी तरह से प्रदान करने पर विचार किया गया सबूत और एक घटना को पहचानने के लिए योगदान मल्टीमीडिया दस्तावेजों से।

हमने एक ओटोलॉजी-निर्देशित मल्टीमीडिया को डिजाइन और कार्यान्वित किया है टैगिंग अनुप्रयोग जो इसके लिए एक व्यापक आधार प्रदान करता है संदर्भ जानकारी के आधार पर मल्टीमीडिया सामग्री टैगिंग। दस्तावेज कॉरपस का इस्तेमाल करके स्वचालित रूप से गठन किया गया है संदर्भ संबंधी जानकारी ताकि अर्थात् रूप से गठबंधन को आत्मसात किया जा सके विभिन्न वेब स्रोतों से दस्तावेज। यह बाद में उपयोग किया जाता है घटना पैटर्न के वैचारिक विकास को अस्थायी रूप से पहचानने के लिए साथ ही स्थानिक रूप से। वैचारिक विकास का पता लगाने के लिए समय के साथ की घटनाएं, टेम्पोरल ट्रेंड विश्लेषण का उपयोग किया गया है। यह सांख्यिकीय विषय मॉडलिंग और विषय-टू-अवधारणा मानचित्रण का उपयोग करता है समय के साथ विषयों पर एक अवधारणात्मक टैग को जोड़ने के लिए दृष्टिकोण। अंतरिक्ष के ऊपर घटना के पैटर्न के उद्भव को ट्रैक करने के लिए, भौगोलिक ट्रेंड विश्लेषण का इस्तेमाल किया गया है। इसके लिए, भू-स्थानिक ज्ञान जिसका फायदा उठाया गया है, भौगोलिक नामित संस्थाएं हैं के विकास की पहचान करने के लिए टेटोलॉजी अवधारणाओं पर मैप किया गया घटना पैटर्न स्थानिक। हम की क्षमता के

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Glossary

OWL	Web Ontology Language
MOWL	Multimedia Web Ontology Language
VERL	Video Event Representation Language
SVM	Support Vector Machine
CPT	Conditional Probability Table
XML	Extensible Markup Language
HTML	Hyper Text Markup Language
BN	Bayesian Network
OM	Observation Model
E-MOWL	Multimedia Event Ontology Language
LDA	Latent Dirichlet Allocation
SIFT	Scale-Invariant Feature Transform
Corr-LDA	Correspondence LDA
NLP	Natural Language Processing
NER	Named Entity Recognition
hLDA	Hierarchical Latent Dirichlet Allocation
CRP	Chinese Restaurant Process
GIS	Geographic Information System