

A Survey of Automated Multimedia Presentation Generation Frameworks

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ABSTRACT

The widespread usage of multimedia data in recent years has led to an enormous interest in making these data available through the Web. Due to the complex requirements of multimedia data, the design and implementation of web-based information systems to fulfil the search, retrieval, and presentation necessities for such systems is not a trivial task. This paper surveys systems and methods for creating meaningful multimedia presentations to answer user information queries. Initial work in this area is carried out by introducing a standard reference model for the intelligent multimedia presentation systems (SRM-IMMPS). The standard reference model introduces a high-level architecture and a plan-based approach to generate automated multimedia presentation. The paper focuses on annotated multimedia data processing and describes different frameworks for automated multimedia presentation generation.

Keywords: *Automated Multimedia Presentation, Knowledge-driven Presentation Generation, Semantic Web.*

1.0 Introduction

In the current Web, most of the information search and retrieval systems are typically limited to list the links or objects to form the user query results. Although, current advancements of the Web and information presentation systems allow having rich media enabled information presentation in the form of hypermedia, most of the current information search and retrieval systems only list the results as hyperlinks to the users. Various research in this area have focused on developing efficient methods to provide more relevant information and enhancing the ranking algorithms such as PageRank [1], HITS [2], Teoma [3]. On the other hand, the user's main purpose of searching for information is frequently obtaining the knowledge, not the list of the related documents. By employing an automated multimedia generation mechanism, information retrieval systems would be able to present the query results to the users in an enhanced form acting as knowledge retrieval systems instead of being only information retrieval systems. The use of multimedia data along with different knowledge representation techniques improves the quantity and quality of information manipulated by information retrieval systems in areas such as medicine, and computer aided design. Intelligent multimedia presentation generation is a discipline to exploit knowledge-base and reasoning amongst other techniques to produce meaningful presentations for query answering systems [4].

The initial work in this area is carried out by introducing a standard reference model for intelligent multimedia presentation systems (SRM-IMMPS) [5]. The standard reference model describes high-level design characteristics and plan-based approach to generate multimedia presentations. The proposed approach assumes that the required attributes and specifications of multimedia data are available and it only focuses on describing a plan-based approach to create the multimedia presentations. The model emphasises the significance of knowledge representation and processing in producing adaptive multimedia presentations.

The information search and retrieval and finding more relevant and meaningful results amongst a tremendous amount of different types of information (i.e. text, image, video, etc.) is an immense challenge for the next generation of the search engines. The analysis and interpretation of meaningful relationships between the users (social network), contents (semantic web) and the context (user preferences, and environment status) are some of the issues that could help in providing more intelligent and effective information search and retrieval mechanisms for the next generation of the Web. The information system design has also been recently influenced by state-of-the-art Semantic Web technologies. The Semantic Web technologies enable the system to effectively express and manipulate the knowledge over the Web. The knowledge representation and reasoning mechanisms of semantic web could also facilitate generating personalised, and enhanced multimedia presentation through an automated process. In this paper we study some of the current advancements in semantic-enhanced multimedia presentation generation systems.

2.0 Presentation Generation Frameworks

In some respects, the presentation generation process is similar to movie making. Here a structuring process is concerned that the individual shots that have been created are assembled into sequences which are grouped into scenes containing a single coherent line of the story [6]. A presentation generation system has the same goal of

communicating a message to the user. In order to achieve this goal, the system is required to specify the individual parts of a presentation. To enhance the authoring process, these specifications should be defined as transparently as possible and should emphasise on manipulation of messages rather than on presentation parts. This requires the presentation items to be organised in a way that supports higher-level narrative manipulation. In this section we study the different approaches used for the presentation generation systems. We begin our analysis by investigating a number of automatic and semi-automatic presentation generation systems. We study the construction of (semi-) automatic presentation systems through four major steps as defined by Bordegoni et al [5]:

- i. selecting and addressing the items of the presentation based on the queried topic (with regards to a knowledge-based reasoning process);
- ii. specifying the narration structure of the presentation and organising the multimedia objects through different slots;
- iii. organising the items into a coherent presentation structure, which includes the temporal and spatial layout specifications;
- iv. specifying the interaction between the user and the presentation system (e.g. refining the query results based on user's detail selection, user preferences, presentation style, etc).

Our analysis of the presentation construction production process concentrates primarily on designing an automatic narration generation and organisation system that supports the first three of these—the selection, narration generation and structuring processes. We are less concerned with the last—the interaction between the individual users with the system—which requires the user profiles and user interaction handling mechanisms to be used. Neither do we focus on the data formats used, nor the necessary trade-offs for presentation environments' requirements that the presentation is intended to be played on. We consider data objects as annotated items, and data format that each particular item represents would require synchronisation, bandwidth, and other similar considerations which are far from the scope of this paper. As far as we are concerned, data formats which could be played/shown through a Web interface satisfy our requirements.

2.1 HERA- Presentation Generation Based on Ad-Hoc Query

The HERA project [7], [8] describes a methodology to generate dynamic hypermedia presentations based on an ad-hoc query. The automatically driven hypermedia presentation is generated through different sources of intelligence which are embedded into the system. The design knowledge shares the designer's expertise and expresses guidelines to present the data collections. The navigation design for HERA is specified based on slice concepts which are adapted from the RMM data model [9]. The navigation structure encounters the "slice" as a hierarchical composition of retrieved data and in a higher level of abstraction as a set of slices which are provided to the hierarchy.

The HERA system is logically represented in two main components: presentation manager and data manager. The presentation manager is responsible to handle all the user interactions and to deliver the generated hypermedia presentation to the user. The data manager translates the user's query into system's query form based on the underlying database. The presentation is arranged in frames, where each frame contains sub-frames that include the slices. The data manager only delivers a part of the retrieved information to the presentation manager and keeps the other relevant frames in the store. The other parts of the information are not included in the current frame structure. During the presentation browsing session, when the user focuses on a specific concept which is not included in its detail record or slice at the current frame structure, this particular part of information is retrieved from the available backup slices [10].

2.2 SampLe - A Multi-layered Semantic Knowledge Framework

Falkovych et al [11] described a framework for semi-automatic multimedia presentation generation process. The system utilises contextual information in a framework to access, interpret, evaluate and manipulate the presentation structure. The system includes an interactive interface to compose the multimedia presentations with the user control. The system, which is called *SampLe*, employs the Semantic Web technologies and defines domain, discourse, and media ontology for underlying knowledge-base. The authoring process in *SampLe* is defined through the following steps.

- Theme identification: defines the presentation theme in terms of content, media types, and interactivity.
- Specification of presentation structure: specifies selecting and changing of the presentation structure through the genre templates.
- Collection of material: provides the information retrieval mechanisms depending on the selected or defined genre.
- Arrangement of material: defines a coherent sequence for the content and discourse structure.

In order to facilitate the above steps, the system requires media dependent and also contextual information in a particular domain. In this way, *SampLe* suggests three layers of the annotation for the data items which are described in the following.

- Domain annotation: contains a domain specific meta-data description which in particular is fine arts. This domain meta-data describes the domain concepts and their relationships.

- Discourse annotation: defines the role(s) of each particular object in the domain. Each information unit can play role(s) in the presentation with respect to its defined domain characteristics and construction status.
- User related annotation: defines the relevancy of the information unit to a particular group of users (e.g. student, teacher, expert).

The strength of the system is in using an ontology to map the user specified topic to the discourse domain concepts. When the presentation topic is specified according to the system known concepts, the objects would be selected and retrieved from the repository. Another important feature of the system is using predefined templates as genres and assigning roles to the entities. The genres define the conceptual parts of the presentation and with a role based approach the main characteristic and following objective would be selected and bound as multimedia elements to the presentation structure. Although SampLe attempts to define user interface and an interactive environment to create user navigated semi-automatic multimedia presentation, it proposes a framework that can be used in order to satisfy some of the main requirements for an automated presentation generation process.

2.3 Creating the Structure through Semantic Inference

Little et al [12] described an intelligent semi-automatic multimedia presentation generation approach using a semantic inference mechanism. They proposed a high-level architecture which generates multimedia presentations by using both reasoning and multimedia presentation generation tools. The meta-data schema is represented based on Dublin Core [13] and OAI [14] archives for metadata descriptions. In Little et al's work, an inferring engine processes the OAI and Dublin Core metadata. It applies logical rules to find out the semantic relation between the items. As a result, data items and their peer items would be the potential candidates to participate in the individual slides of the presentation structure. After semantic inference, the system employs a set of semantic relationship using a hierarchy in which all semantic relationships are derived from the top-level MPEG-7 semantic relationships [15].

The system employs mapping rules to describe the logical spatial and temporal constraints. A set of mappings illustrates the corresponding mapping from the MPEG-7 semantic relationships to the spatio-temporal constraints. This approach to express "grouping" between media items is to align them together spatially which is required to generate the final presentation structure. The significant aspects of Little et al's work are the iterative search process (iteratively search and navigate the OAI archives), semantic inference (Dublin Core meta-data and logical reasoning are used to realise meaningful relationships between the objects), mapping process (the inferred semantic relations are mapped to the spatial and temporal constraints), presentation generation process (generating the presentation based on media objects, relations, mapped semantic relations), and user-directed presentation (when user asks to regenerate a presentation by selecting a media item of interest in the current presentation). The generated presentation is presented in SMIL [16] format and could be stored and replayed by referring to the generated SMIL document. Although the system focuses on automatic processing of metadata to integrate semantically-related objects within multimedia presentations, it does not effectively employ the common knowledge representation techniques. An effective solution could be using ontologies to represent the common knowledge and employing reasoning mechanisms to interpret the relationships through an interoperable and flexible framework. Little et al did not also report focusing on user intentions and perspectives on the queried topic to generate context-aware and enhanced multimedia presentations [12].

2.4 Virtually Zero Input Presentation Environment (Vizipen)

Vizipen [17] is a semi-automatic multimedia presentation generation system. The system is designed for educators and in particular K-12 teachers to prepare animated visual presentations. Vizipen employs XML serialisation to represent content specific description of multimedia resources. These specifications are called indexes. The multimedia indexes are defined based on contextual and content analysis for the objects. A multimedia web search agent is used to identify multimedia content elements on the Web and to associate semantic information to them. The elements and their associated semantics are then stored into a relational database.

The automatic multimedia element collection and semantic associations are enabled through a knowledge-base. In particular, Vizipen uses digitised curricula that are represented through a knowledge-base. The concepts are classified as the following categories: people, places, locations, artefacts, events, documents, celestial objects etc. Each concept in the domain knowledge is represented as a "topic" and the topics are associated to the categories. For example "Abraham Lincoln" can be a person or the name of a ship. In this case, the associated category identifies the type of the provided "topic". The approach is very similar to the Semantic Web knowledge representation methods, but Mariappan and Aslandogan [17] did not report using Semantic Web technologies to represent the domain knowledge or interpret the meaningful relationships between the concepts. Using XML for concept representation and describing the resource has its own limitations. XML is mostly suitable to describe the contents within the documents, but not amongst the documents [18]. The domain concepts are represented in XML topic map [19] and could be transformed into standard knowledge representation format (e.g. hierarchical format), in order for easy adaptive navigation during the presentation. The system includes a presentation template engine that is a database of predefined animation templates with replaceable components. These templates are created using SVG [20] and HTML+TIME [21]. The presentation generation engine facilitates automated presentation generation by

assigning objects to the predefined structures. The generator uses XML and the XSLT [22] to produce the ultimate presentation.

In Vizipen, the presentation is associated with a topic and knowledge descriptor document which is extracted from digitised curricula represented as concepts in the categories. The multimedia presentation that contains media objects is automatically generated using replaceable templates (from template engine), contextual data (concept dictionary) and the multimedia objects (from the multimedia database). There is a major challenge in associating the concept dictionary artefact and multimedia elements in the data source (whether they are retrieved from the web using an agent or they are manually inserted objects). The system specification provides help agents that are responsible for contextual analysis and classification. Consequently, the indexing and retrieval process for multimedia objects in a particular subject is strongly dependent on the detection and identification process in the system and the web-based information collections which address a wide-range of multimedia objects as input. Since the Web provides a widespread collection of different information from different domains and in different representation forms and terminologies; this would be a challenging issues with regards to the generated presentation's accuracy and credibility.

2.5 TOPIA - Structuring and Presenting Annotated Data

Rutledge et al [23] described a framework to generate hypermedia presentation from annotated multimedia data stored in an RDF repository. The discussed research focuses on using Semantic Web technologies and information presentation through the semantics and contextual meta-data. The RDF data is stored in an RDF repository and queried using an RDF Query Language [24]. The user submits a query in text format and then the system encodes the text query to the RDF Query Language. Initially all the data items that match with the query topics are selected and form the leaf nodes of a hierarchical structure. The system extracts a sub-graph from the main RDF graph (knowledge-base) structure. The nodes, hierarchy and their sequence are included in a document model which is called structured progression. The submitted query is used to select the concepts and to form the leaf nodes of the structured progression. The clustering process then finds additional resources that form the composite nodes. The composite nodes are expressed using lattice and inference rules. The lattices are formed through the leaf node and relate data sources with common properties. The inference rules refer to the domain knowledge to realise the roles for the objects and fulfil certain template rules' requirements. The proposed system employs the Dublin Core meta-data specifications to represent the attributes and explanations for the media items. In this way, Dublin Core is provided as an RDF-encoded set of meta-data tags. The system queries Dublin Core tags and retrieves the multimedia objects based on the link to the binary object in their RDF descriptions.

The significant issues in the above are forming the enhanced structured progression and generating the final presentation based on the clustering and inferring processes. The clustering uses lattice clustering algorithm and emphasises using common features of the leaf nodes to determine the other related data. The semantic relation extraction involves processing the RDF graph in the repository. The inference rules stipulate the selection of relevant object based on the RDF detail class and property descriptions, i.e. `rdfs:subClass`, `rdfs:subProperty`. The clustering component accesses the RDF repository and applies the rules for concept lattice preparation. The system creates the stories through a combinational approach. The data resources are selected based on the query and clustering mechanism (bottom-up design) and the higher level information are applied to the structure to organise the presentation (top-down design). The proposed system is domain dependent and uses discourse information. In a recent work, Rutledge et al [25] have reported using domain semantics rather than discourse information. In this case, the hierarchical structuring is still used to present the group of relevant results to the user. However, the same results could be classified in other relevant groups [25], [26].

2.6 Adaptive Presentation Generation

Aroyo et al [27] proposed a hypermedia generation systems which deals with the external as well as the internal information resources. The outside information is retrieved by the information retrieval agent from the Web. Aroyo and his colleagues believe most of the applications focus on the local data sources which have fully known features. They propose a framework which deals with partially known information included from external resources and in particular the Web. Although the main focus of their work is on collecting the information rather than the presentation generation itself, the proposed architecture provides a structure to deal with the multimedia information in terms of meta-data processing and selecting appropriate objects.

Aroyo et al's system [27] defines three main components to support the adaptive hypermedia presentation generation. The components are represented as, user model, domain model and application model. The domain model represents a semantic structure of the concepts and relationships between the concepts in the system. The concepts and their descriptive attributes are defined in a domain model. It conceptualises the entities and defines how this entities are related to each other in terms of domain relationships. The user model is an overlay model of the domain model which defines the same concepts and associates user-attributes to the represented concepts. For example, the concepts are represented in different topics and levels in the domain model, and the user model defines the user's level of knowledge or interest for these concepts. The application model is a set of rules which link the domain and user model in order to generate the final presentation. In fact, the application model defines the

constraints and rules for presentation construction and structuring purposes. The crux of the system is how the information retrieval agents' result is related to the domain concepts. In the context of the local data, it sounds straightforward, the information is described with the domain model attributes and the system refers to domain and user model to process and select the appropriate data. In the case of "external contents", the situation is different. The system employs an ontology to "reason" the external data which is collected using an information retrieval agent. The ontology defines associations between the terms known as concepts in the domain and the external concepts. Although all the attributes of the outside contents are not known to the system and they might use different terminology to describe the data, the ontology works as an interface to provide interoperability between the external terms and the system concepts represented in the domain model. This allows the author to use perception and knowledge of the search space to demand for external resource search and retrieval.

2.7 MANA- An Automated Hypermedia Presentation Generation System

MANA [28] is an integrated hypermedia presentation generation system which is divided into 4 layers, namely resource, discourse, aggregation and presentation layers. The resource layer provides the explanatory and binary resources. This layer maintains a standard interface to access the documents and their descriptive attributes. The discourse layer corresponds to the domain ontology and enables the system to select the candidate objects to be included in the presentation based on their relevance to the submitted query and also their meaningful relationships. The discourse layer contains an inference engine which is responsible to search for the complex relationships (i.e. semantic associations) between the objects according to the domain ontology concepts. Fig. 1 illustrates instance semantic associations between the objects in a painting Art domain ontology.

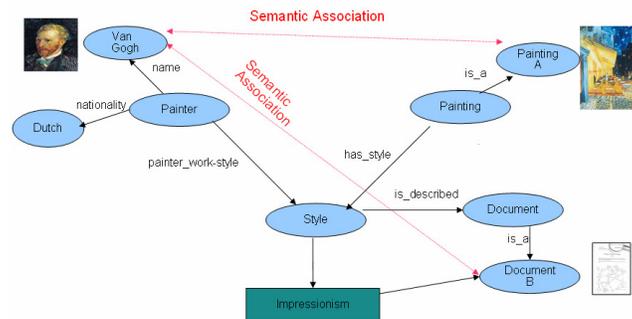


Fig 1. Semantic associations in a sample domain ontology

The inference engine also provides a ranking mechanism for semantic associations. The system uses the ranking measurements to extent a presentation spanning over a topic selected from the knowledge-base. The ranking weights are used to define the robustness of the semantic associations between the main entity and other entities. This produces a weighted graph structure which is used as the fundamental narrative structure to organise the hypermedia presentation. The aggregation layer uses event based representations of the candidate results to generate the narration structure. The presentation layer includes a set of templates and refers to the presentation genre to select one of the templates and generate the presentation layout based on the specified features [27], [28]. Fig. 2 shows the presentation generation steps in the MANA system.

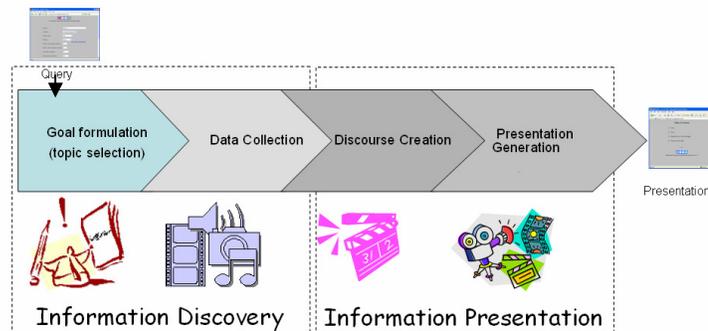


Fig. 2. Presentation generation steps in MANA

The importance of including the tasks in the separate layers is that each can be replaced by a similar component while leaving the system structure itself unchanged. This allows multiple implementations for different components and also applying different ontology and data representation models in the same underlying system architecture, e.g.,

the layout can be tailored to specific output environments, the domain ontology can be changed with a different domain ontology. The resource layer uses an RDF/XML repository and also a relational database. An important aspect of the layer is that the resources are represented in the standard semantic web format where the structure is based on the proposed data model and the specifications are independent from the other layers. The discourse layer which includes the inference engine also acts independently. Although, the specifications in the discourse layer are domain dependent and corresponds to the domain ontology, the inference engine functions autonomously. This means changing the discourse domain as long as the data is represented based on the designed data model does not affect the inferring process. The aggregation layer customises the narrative of the presentation based on the contextual perspectives and associated ranks. In this context, as long as the designated context-indicators correspond to the concepts in the domain ontology the narration creation process would be a self-determining process. The standard template specification in the presentation layer facilitates a uniform approach to structuring and generating the hypermedia presentation compositions. Temporal and spatial layouts play a particularly important role in hypermedia presentations, and these aspects have to be coordinated among multiple objectives of the presentation. The presentation layer considers these aspects based on the presentation genre, output environment, bandwidth, and presentation size.

3.0 Presentation Generation Systems- Summary

The reviewed works demonstrate different approaches to presentation generation process with more or less capabilities in the web-based environments. The multimedia presentation process could employ simple pre-defined template that is filled-in with media items during the presentation generation process. In this case all the spatial, temporal and navigational structures are predefined and predetermined. The user only defines the presentation target, and then the presentation goal proceeds to select appropriate data items. The selected media sequentially fill in the predefined template. An alternate approach is using enhanced structures which include flexible spatial, temporal constraint specifications. In this case, various constraints are taken into account during the presentation structuring phase to define the dynamic template of the presentation. In some works the meaningful relationships between the objects are used to analyse and select the information from the data sources (e.g. Little et al' work described in [12], and MANA [28]).

A rhetorical structure could specify how the relationship between the objects could be used to define the structure of the presentation. It is similar to what is called design ontology in Rutledge et al [23]. The expert knowledge is expressed as a set of rhetoric constraints. Once the objects are selected, the rhetoric structure will be used to analyse the collections and then based on the relationships between the document objects, the rhetoric constraints will be added to the presentation design structure. The realisation process translates these constraints to appropriate rules in the form of presentation generation structure. Our design for an automated presentation generation system, MANA, is inspired by the standard Reference Model for Intelligent Presentation Systems (SRM-IMMPS) [5]. In MANA, the presentation generation system is defined through the following layers: Resource Layer, Discourse Layer, Aggregation Layer, and Presentation Layer. MANA employs implicit data hidden in the relations between the objects and the user preferences to extract explicit knowledge about the objects and to organise the objects in a presentation scenario. The domain ontology and the narration ontology are used for specifying high level knowledge about the discourse domain and the presentation structure. We have emphasised the contribution of the knowledge representation to the automatic presentation generation process. The system utilises an inference engine which is responsible to realise the relationships between the objects. With regards to typical information search and retrieval systems, we introduce a knowledge-driven query answering system which provides a multi-paradigm search method based on different attributes and ranking metrics. Table 1 demonstrates the desired feature for different reviewed work in the previous section.

Table 1. The features of the reviewed works

Reviewed work / Features	MANA	HERA	SampLe	Little et al	Vizipen	Topia	Arayo et al
Discourse-based and context-based annotation	Yes- uses event marker to assign event indicator(s)	No	Yes- defines role(s)	No	No	Yes	No
Using ontology for knowledge representation	Yes	Yes	Yes	No	No- employs a concept dictionary	Yes	Yes
User modelling	No	No	No	No	No	-	Yes
Using public standards for data collections	Yes- RDF	-	-	Yes- XML	Yes- XML	Yes- RDF	-
Using public standards for output	Yes- DHTML and SMIL (under construction)	Yes	Yes	Yes- SMIL	-	Yes- SMIL, DHTML	-
Automatic narration definition	Yes	No	No	No	No	Yes	No
Context-oriented story telling	Yes	No	No	No	No	Yes- using theme and genre to structure presentation	No
Ranking the complex relationships	Yes	No	No	No	No	No	No

4. Conclusion

The idea behind the automated multimedia presentation generation mechanisms is that the system instead of providing a list of results, as what happens in the typical information search and retrieval systems, collects a list of candidate objects based on the relevancy to a query and also semantic relations between the objects and presents the results as a rich multimedia presentation to the user. It is more than 10 years that the Standard Reference Model for Intelligent Multimedia Presentation Generation has been introduced by Bordegoni et al [5]. In recent years different works have contributed to implement the model or other methods to enhance and employ annotated multimedia data, and to obtain user's interest on a query topic in order to knowledge-driven and context-based presentations.

While we feel that the components designed in different systems are, apart from the reported omissions, functionally adequate, they do not necessarily present a comprehensible architecture for an intelligent multimedia presentation generation system which provides satisfactory results to a query at the level of results list provided by the current Web search engines such as Google. Questions can be asked on: how do the systems work for a huge set of data when for each level they may retrieve a number of candidate objects, and how the individual components of a presentation generation process can be improved to enhance the presentation structure. In particular, there may be better ways of integrating the different parts of the systems with each other and better ways of processing the results and visualising the correspondences among the objects in order to generate an enhanced presentation. The dynamic ontology creation and updating will also improve the functionality of the system and will facilitate a broader range of information resources to be accessed by the system. Other improvements lie in the area of interactivity of the interface, e.g. by allowing the user to manipulate and alter the templates, for example to change the structure and order of the events or styles to generate a more customised presentation template.

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