I4: Immersive, Interactive, Individualized Information

1. Research Team

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2. Statement of Project Goals

The goal of Immersive, Interactive, Individualized Information or I4 is to immerse people in interactive, customized multimedia information experiences and to provide organic, intuitive tools for maintaining the underlying content system. Rather than a person querying an information system and getting back some search results, they will receive an integrated information presentation or 'story'.

The next generation of information presentation requires a new paradigm of structure and narrative that changes according to a person's preferences, interests and choices. A person will not only be immersed in interactive "stories" filled with multimedia elements and a wealth of customized background, but the information presentation will reform and change into different 'experiences' depending upon the viewer [1-4].

In its most basic form, I4 seeks to offer the user a wide choice in presentation, from plain text, which is the spine of the narrative, up through a range of enhancements, starting with hypertext links to other stories, documents, photos, video and audio clips, and other multimedia content. A wide range of users will experience information in drastically different environments, and will interact with virtual stories in equally diverse ways.

Beneath the audio-video-sensate interface of I4 lies a rich (virtual) database of information, one that constantly updates itself and changes topics instantly and automatically depending on the person's preferences, interests and choices.

Enabling this vision of I4 requires the development of the following capabilities:

- (Semi-)Automated Content Analysis and Storage
- Dynamic Ontologies
- Information Presentation Models and Templates
- Organic Authoring Interface
- Request-Information Presentation System

- Generation of Interactive Information 'Stories'
- Interactive User Interface
- Capability for Modality Conversion
- User Profiling for Customization

Each of these requirements for I4 enables core functionalities of the news system, from authoring to user interactions to story generation.

At the core of I4 is a library of multi-modal content that is related through a rich ontology. From text articles to video clips to statistics, all content is tied into a common ontology that is used to extract elements for information presentations. But this ontology cannot be static. New facts, media and reports are added every day. Yet current data organizations do not have the infrastructure or capabilities to hand-index content entering their systems. As content is entered or acquired, agents must analyze the information – from regional analysis in video to concept identification in text – and automatically enter the content into the system and create relationships in the ontology. And if current ontology nodes do not exist for concepts in the content, the agent must be able to create new conceptual nodes automatically and then relate the information into those. When people and objects appear in video, the computer agents will search against a library of identified concepts. Matches will be labeled and tracked through the video. And identified concepts in all media will be linked to their ontology nodes, so that behind identified people or concepts in a story lies all of the related content in the system.

When an information story is generated for a user, the news consumer does not receive the same static report on a topic that another user might. Each story is customized according to a user's query (as well as a user's preferences and history), both in the content that makes up the story and the actual form it is presented in. When a user enters their request, it is analyzed and broken down into the concepts in their request and the intention of their question. Content is matched through the concepts in their request and the system's ontology. But I4 does not just return the items that match their question, the way a traditional query system would, but also analyzes the intention or implicit goal of their request. The system then makes evaluations as to how to best structure the 'story' about their question. To do this, we must create abstractions of narrative structures called presentation models or templates (depending on the level of detail in the structure). These are meta structures with rich specifications that define how content should be combined and formed. The system will select the best model for a user's request and will construct a custom information story, combining the (multi-modal) content that matched their question according to the specifications of the model.

More than mere information results, the goal of I4 is to create information 'experiences'. For example, a story that appeared on a stereoscopic monitor might appear traditionally two-dimensions, until the user began asking questions about people or concepts, and pieces of information began appearing on different visual levels. But news stories must be able to customize to any environment, from a hand-held, text-only device to a computer screen. This will at times require converting media downward, from panoramic video to normal (singe-screen) video, to video to text, to the perhaps reverse – taking relatively simple content such as text and images and rendering them in a virtual environment.

A crucial aspect of I4 is the existence of an easy-to-use, graphical user interface for interacting with and altering the operation of the system. One of the project's goals is to avoid adding new levels of technical knowledge requirements and training to content professionals. With automated content analysis, operators will not have to spend copious amounts of time entering content and media into the system. But they must be able to manipulate the content and the underlying system in a meaningful way. The authoring interface would allow for such tasks as ontology manipulation and maintenance, construction of new presentation models and editing of content through an organic GUI.

3. Project Role in Support of IMSC Strategic Plan

I4 will provide new capabilities for enabling technology in realization of the IMSC vision. Its capabilities are in response to requirements from the education, entertainment, and communication vision projects. I4 will interact strongly with key research sub-areas crucial to IMSC such as multimedia content extraction and management, information integration, customization and ontologies, robust vision analysis, speech recognition and synthesis, and performance assessment.

4. Discussion of Methodology Used

To realize the I4 vision, there are four key areas of research focus: development and integration of the necessary technology; construction of the experimental system; acquisition and refinement of content; and testing, evaluation, and assessment.

In conjunction with the IM research sub-area on multimedia content extraction and management, we are developing new techniques for multimedia content representation and structuring, information representation and structuring, and semi-automatic and automatic information 'story'/presentation generation. Techniques for user customization will support the development of new tools for presentation, providing more information about specific part of the story, and in fact altering the story according to the user profile. Metrics for measuring the effectiveness of user customization will be developed and applied.

Techniques for multimedia information integration and fusion will be developed and employed to link database information to stories, and to link stories and story types. Ontology-based techniques will link multiple stories with the user request. User interaction will be via (constrained) natural language; here we will employ state-of-the-art techniques, based upon rich domain ontology. Finally, we shall develop mechanisms to support story delivery and presentation into varied user environments.

On the content access side, I4 will build an information story according to a user's input and profile, created from past access as well as user-provided information on preferences, communication style, etc. [5]. An immersive, interactive, multimedia story is delivered to the user based on all of the above. At any point in the information presentation the user can not only expand the coverage of certain elements or subjects, but the core news narrative will alter according to feedback.

Underlying this, our research must devise, experimentally implement, test and practically demonstrate techniques and mechanisms to support the user-personalized generation and delivery of multimedia stories/presentations [6-8]. In our approach, we employ profiling information about a user in order to customize a response to an information request (query) by that user. We employ meta-data description techniques, which reference an ontology that describes the key concepts and their inter-relationships in the collection/database being used [9]. User profile information includes communication style, preferences and a personal ontology (describing the user's perspective). We utilize applied knowledge processing techniques to automatically select appropriate information to incorporate into a story. Importantly, we then generate a specific multimedia presentation for the user, which responds to their query in their context. The multimedia presentation is then delivered to the user, interactively and in real time; the delivery may be via wired or wireless network.

5. Short Description of Achievements in Previous Years

Initial research has focused on developing an ontology model, content acquisition, request processing and integration with speech recognition, story rendering, and development of a graphical user interface of I4.

The first fully realized I4 system (previously called I-News) featured initial versions of all core modules – user interface, request processing, ontology, and 'story' generation. This brought together disparate pieces of data, some with their own internal narrative structures, into custom information presentations – with the process controlled by user queries. A flexible ontology was created that established relationships between content and more abstract concepts, with the concepts organized within a hierarchical parent/child node structure. In one model, multiple elements – including video, audio, images and text – were integrated into a multi-leveled story with a primary narrative.

The next year witnessed a refinement of the request processing and story generation modules, an exploration of alternate ontology models, expansion of content to wider areas of content (cross-sections of content in different areas) to further test and stress the system, exploration of alternative user interfaces for interacting with stories, and initial research into abstracting information patterns and approaches to narrative structure into story models and templates.

5a. Detail of Accomplishments During the Past Year

Initial research into information presentation models resulted in categorization of model components and a small number of manually constructed information presentation templates.

Rudimentary speech recognition was added to the system. Specifically, a dynamic, limited vocabulary was created from the system ontology and synonym list spoken requests can be processed with speech recognition using that vocabulary; recognized terms are processed as user requests into the story system. Initial research into this area, as well as future, more complicated iterations, will be coordinated with similar speech-based interaction research in the other three projects.

Research into user behavior historical modeling represented the first component in I4's User Profiling. A user's request history is used to narrow or expand the requests from that user. This research parallels similar user history and modeling efforts in the area of education; these projects will share research in acquiring, querying and analyzing user immersidata.

The concept of a topic-based ontology was introduced into the system. In parallel with the concept-based ontology, the creation of topics is semi-automated from analysis of concept and topic clustering across content.

6. Other Relevant Work Being Conducted and How this Project is Different

Many media organizations have experimented with creating new forms of information narratives, from "info games" [10] and three-dimensional representations of information to multimedia presentations and slideshows [11] of news. But the current endeavors in this direction are time-consuming to produce, and only leverage the most basic and limited of news information. They cannot generalize to other genres of information. And the narrative structures of their information presentations are static, their degree of customization and interactivity is minimal [12,13], and they feature relatively conservative user interfaces.

Some academic organizations that focus on information presentation – such as the MIT Media Lab and the Center for New Media at the Graduate School of Journalism at Columbia University – are focusing on some of the theoretical data issues of I4. These include understanding content, profiling individuals, and customizing presentation and interface and applications to them [14]; creating new interactive multimedia prototypes [15]; and researching content-based image and video retrieval and natural language retrieval and summary generation [16]. But the tangible goals in their research are isolated and limited in their scope. They lack an integrated model such as I4 that would leverage and fully realize research breakthroughs in these areas into an integrated system.

7. Plan for the Next Year

For 2004, rudimentary Presentation Models will be leveraged to create different versions of information stories out of the same content.

The behavior and content of I4 will also be further customized based on analysis of user history and interactions with the system.

Agents will collect a wide array of public content (from databases and the Web), which will be analyzed, deconstructed and then automatically entered into the content database.

Initial attempts at semi-automated ontology creation and maintenance will be integrated into I4.

And research into automatic annotation of content (and sub-regions of content) will be implemented into the authoring and content matching components of the system.

8. Expected Milestones and Deliverables

The functional requirements for I4 and the underlying scientific research intersect through integration milestones. Spread across the five-year scope of this project, each milestone represents the culmination of research in areas critical to the development of I4 and the realization of the project requirements and overall vision.

Automated ontology augmentation (Years 2-3):
This milestone represents an important aspect of the system – the ability to create new nodes in the underlying ontology with little or no user intervention. Enabling aspects of both the Dynamic Ontology and Automated Content Analysis requirements of the project, when unknown (strong) concepts are encountered in processed content, the system will attempt to create new nodes in the ontology for those concepts. This represents important information management research into ontology construction.

Video region analysis, identification and tracking (Years 2-3):
The ability for the system to recognize previously identified regions/objects in video is a crucial aspect of the Automated Content Analysis requirement for I4. For this milestone, when video content is fed into the system regions (people, objects, etc.) that have been identified into previous media (and entered into a library) will be automatically recognized in the new video. There will also be authoring tools to define an (unrecognized) region and identify and enter it into the video library. This research will integrate efforts in video analysis and storage with information integration and ontology relationships.

Supplementary content agent (Year 3):
An important aspect of the Automated Content Analysis requirement of I4, this milestone will enable the system to extract information for the content system from the Web. A computer agent will search through flagged Web sites for information relevant to ontology concepts. The agent will extract and process matched data and will enter them into the system and create ontology relationships with varying strengths between the new content and the concepts. This research will bring together ontology and search agent efforts within the area of Information Integration.

User settings (Year 3):
An important milestone for the system requirement of User Profiling, this project will enable users to adjust settings in the system such as communication style and preferences, system options, content areas and interests, etc. The historical behavior of a user will not only be analyzed and tracked, but the results will be exposed to users. They will be able to alter how the system uses that information to alter how it processes requests and renders stories. The research in this area will complement efforts in the Education project to customize classroom content toward student preferences.

Modality conversion (Years 3-4):
Enabling the Modality Conversion requirement, this project will enable content to be converted between different modalities. For instance, concepts and meta data such as narrative progression in video will be converted for text rendering, and text will be rendered in speech. Media will also be converted between different bandwidths.

Automated extraction of sub-sections of content (Years 3-5):
An important aspect of the I4 vision is automation of content analysis and processing. When content is processed by the system, that content is not only analyzed for concepts, but agents should be able to segment content and extract sub-sections. Content segments are not only stored autonomously with their own ontology relationships, but they must also be related to their parent content and the parent's ontology relationships and annotated.

GUI creation and editing of information presentation models and package (Years 3-5):
An important milestone in the requirements of Story Models and Organic Authoring Interface, this integration project will allow I4 operators to initially create story packages through a graphic user interface. They will be able to drag stories together to create new structures for displaying related content. Eventually, using a non-technical, graphic user interface, I4 operators can create full information models with rich specifications.

Use of advanced/rich presentation models (Years 4-5):
With this milestone, the full vision of the Information Presentation Models and Templates requirement will be realized. 'Story' models with rich specifications can be used with any content, regardless of its origin, without requiring any hand-authoring or adjustment of content. The system will perform any conversion or editing of content in order for it to be placed within a particular model.

9. Member Company Benefits

I4 has begun to re-tool its collaborators more toward the field of Information Management such as search engine and database companies. We continue to partner with content providers such as the Los Angeles Times, and have received increased interests from more forward-looking media and content firms that are interested in next-generation content systems. We also envision applications to intelligence and information monitoring.

Many individual research areas and modules of I4 could be utilized autonomously (outside the context of an entire information system) by businesses. These include research into dynamic and semi-automated ontologies, user history and behavior analysis and profiling, etc.

10. References

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