

# **Multimedia Search and Retrieval: Innovative Applications and Integration of Searchable Images, Graphs, Video, and Audio to Augment and Complement Textual Search Results**

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In 2008, under the auspices of the International Council for Scientific and Technical Information (ICSTI)'s Technical Activities Coordinating Committee (TACC), the concept for a project on multimedia search and retrieval was conceived. The project's focus was to explore approaches for enhancing access to multimedia scientific data by demonstrating an identification scheme for video, audio, images, graphs, and other visualization tools as well as the integration of these media types into the search and retrieval capabilities of prominent scientific search engines. This final project report discusses objectives, methodology, technology use and adaptation, and outcomes, including the successful release of the U.S. Department of Energy's ScienceCinema (<http://www.osti.gov/sciencecinema/>) website, developed in partnership with Microsoft Research.

Video, audio, images, and other types of multimedia have the potential to greatly enhance the usefulness and communicative abilities of traditional text-based information collections. These new forms of scientific information, including multimedia, numeric data, and social media, are emerging rapidly, with a significant increase observed just over the past four years. Many scientific conferences and symposia, for example, are now recorded, and the presentations are offered to attendees and others in video format. Most of the Department of Energy (DOE) research laboratories have created their own YouTube sites, and are posting videos of guest lectures, experimental procedures, and roundtable discussions. Likewise, the European Organization for Nuclear Research (CERN) also maintains a large collection of video and audio files showing scientific experiments and lectures. Other organizations, such as professional societies and universities, collect and maintain multimedia science information, and continued proliferation of multimedia as a communication medium within the sciences is foreseen.

While visually appealing, and offering numerous benefits above and beyond text-based information, multimedia information does present some special opportunities and challenges. Some of the challenges to traditional search and retrieval mechanisms include the lack of written transcripts, minimal metadata (no abstracts, keywords, or subject categories), and complex scientific/technical/medical vocabulary. Additionally, many of these videos are long, up to an

hour or more in length. For a scientist interested in only one part of a video or experiment, watching a sixty minute video could pose a substantial time burden.

To overcome some of these challenges and barriers, the DOE's Office of Scientific and Technical Information (OSTI) partnered with Microsoft Research on this project. OSTI's mission is to disseminate the research results emanating from the Department of Energy's research investment in basic and applied sciences (over 10 billion USD per year). Since the 1940's, OSTI has carried out this mission for DOE and its predecessor agencies. Initially, collection of research results in the form of technical reports and other publications in paper format was the standard procedure. In the 1990's, the transition to publications in electronic formats occurred. Today, yet another transition is underway, towards the collection of multimedia science information.

Facilitated by the ICSTI TACC, OSTI and Microsoft Research formed a collaborative partnership to work on search and retrieval methods for multimedia science information. A Microsoft research project called Microsoft Research Audio Video Indexing System (MAVIS) was identified as an excellent candidate for use in a prototype system. MAVIS uses state-of-the-art audio indexing technology to enable search and retrieval of spoken words within a video, performing much like a search for text-based information.

Although speech recognition accuracy has increased over the years as a result of improved algorithms and faster, cheaper computational capabilities, automatic transcripts of technical speech content are often not accurate enough to provide high quality search results. To enable high quality search results, along with the ability to "click and play," MAVIS uses a multi pass approach with automatic vocabulary adaptation that uses web search and natural language processing to learn the terminology used in each multimedia file being processed. During the speech recognition phase, MAVIS stores word alternatives to increase the probability that users will find what they are searching for. The result of the recognition phase is referred to as the Audio Index Blob (AIB), which is indexed by the SQL full text indexing service, ultimately resulting in speech content that can be searched in much the same way as textual metadata. Given that the multi-pass speech recognition process is computationally intensive, the MAVIS speech recognition process runs as a Windows Azure service, so organizations do not have to invest in speech indexing infrastructure.

Over the course of about 2 years, OSTI collected over 1,000 hours of video files from the DOE's national laboratories and research facilities. RSS feeds with metadata and URLs for the videos were sent to Microsoft Research, where audio indexing was performed using MAVIS. The resulting AIBs were returned to OSTI, and imported into OSTI's SQL servers. The end result allows users to search for a precise term within the video, and be directed to the exact point in the video where the term was spoken. Using MAVIS technology, OSTI developed a web product called ScienceCinema, which was officially announced and released at the ICSTI Winter Workshop in Redmond, WA on 9 February 2011. ScienceCinema represents a ground-breaking

capability in multimedia search and retrieval. For the first time, the public has access to a large audio-indexed and searchable video collection of DOE-sponsored science information.

**ScienceCinema Website** (<http://www.osti.gov/sciencecinema>)

The screenshot shows the ScienceCinema website interface. At the top is a banner with a camera lens on the left, the text "SCIENCECINEMA" in the center, and a blue helix structure on the right. Below the banner is a navigation menu with links: Home, About ScienceCinema, Help, Audio Search, and Bibliographic Search. A search box is present with the text "Search ScienceCinema for" and a "SEARCH" button. Below the search box is a "Welcome to ScienceCinema!" heading, followed by a paragraph explaining the site's audio indexing technology and its content sources (U.S. Department of Energy and CERN). Below this is the text "A SCIENCE Accelerator Resource" with a logo. The footer contains logos for the U.S. Department of Energy, Office of Science, OSTI.gov, Website Policies/Important Links, SCIENCE Accelerator, science.gov, and WORLDWIDE SCIENCE.ORG. The Microsoft Research logo is prominently displayed in the center of the footer. At the bottom, it says "Last Updated: 07/28/2011". The browser's address bar at the very bottom shows "Trusted sites" and a zoom level of "100%".

**A search for U.S. Department of Energy videos containing the spoken term “biofuels”**  
**Snippets indicate the points in the video where the speaker said the word “biofuels”**

The screenshot displays the ScienceCinema website interface. At the top, there is a navigation bar with links for Home, About ScienceCinema, Help, Audio Search, and Bibliographic Search. Below this, a search bar shows 35 results for "biofuels" with filters for All, DOE, and CERN. Two video results are visible:

- Hope or hype? What's next for biofuels?** by Jay Keasling, Jim Bristow, and Susanna Green Tringe - 2009 Oct 05. This result includes a transcript table with the following snippets:

Occurs at	Result snippet
0:00:06	... — for <b>biofuels</b> sponsored by friends of berkeley lab and cosponsored ...
0:03:02	... <b>biofuels</b> the answer great thanks we'll call ...
0:06:48	... be converted into <b>biofuels</b> — in the form of ...
0:08:19	... oil — if we now turn that into <b>biofuels</b> ...
- Carbon Cycle 2.0: Paul Alivisatos: Introduction** by Paul Alivisatos - 2010 Feb 09. This result includes a transcript table with the following snippets:

Occurs at	Result snippet
0:11:19	... if we can be successful with <b>biofuels</b> and with artificial photosynthesis ...
0:18:37	... can trust <b>biofuels</b> they can touch ...
0:39:16	... — and of course that's what <b>biofuels</b> ...
0:39:20	... uh so <b>biofuels</b> are very exciting in that respect ...

Arrows from the text above point to the word "biofuels" in the transcript snippets of both videos. The website footer includes a "Trusted sites" indicator and a 100% zoom level.

Following the release of ScienceCinema, OSTI and Microsoft were approached by CERN, which, as stated earlier, also maintains a large collection of scientific and technical videos and other multimedia information. The U.S. Department of Energy has long had a productive relationship with CERN, which is a world leader in physics research. CERN volunteered its multimedia material for inclusion in ScienceCinema, and a partnership was formed with OSTI to apply the speech indexing technology to CERN files and to make them searchable through ScienceCinema. The first installment of CERN multimedia content was added in May 2011, and additional content will be added on an ongoing basis.

## Examples of Videos/Audio Files from CERN containing the spoken term “particles”

The screenshot displays the ScienceCinema website interface. At the top, there is a navigation bar with links for Home, About ScienceCinema, Help, Audio Search, and Bibliographic Search. Below this, a search bar shows 13 results for the term "particles". Two video results are visible:

- Antihydrogen Trapped in the ALPHA Experiment** (by None - 2011 Feb 25):
  - Transcript Results table:

Occurs at	Result snippet
0:03:51	... actually mostly gymnastics with charged <b>particles</b> -- and when you have ...
0:03:57	... and finally neutral <b>particles</b> with magnetic moments -- ...
0:12:43	... and developed techniques for trapping charged <b>particles</b> ...
- Antimatter** (by None - 2010 Sep 29):
  - Transcript Results table:

Occurs at	Result snippet
0:02:36	... conservation of charge it produced <b>particles</b> enter particle particle civil charges ...
0:02:52	... of these <b>particles</b> enter <b>particles</b> popping into business they could've gone back ...
0:05:42	... charges of <b>particles</b> ...
0:05:48	... corresponding <b>particles</b> to ...

Arrows from the title point to the search results. The browser's status bar at the bottom shows "Done", "Trusted sites", and "100%".

As part of OSTI’s ongoing processes for collecting and disseminating DOE’s R&D results, additional multimedia content from DOE researchers, from within both the research laboratory and university communities, is also expected to be added to ScienceCinema over time.

In June 2011, at the ICSTI Annual Conference in Beijing, yet another milestone was reached in multimedia search and retrieval of science information. By combining federated search and speech-indexed technology, OSTI announced a new tool in scientific discovery. Online searches for scientific information within large search portals, such as WorldWideScience.org, had heretofore been limited to text-based information. Now, users of such portals have access to multimedia information, and can search and view multimedia alongside textual information on the same topic.

# ScienceCinema results appearing in WorldWideScience.org

The screenshot shows the WorldWideScience.org website interface. At the top, there is a navigation bar with links for Home, About, News, Advanced Search, Contact Us, Site Map, and Help. Below this is a search bar containing the text "Search: Full Text: laser cooling" and a button for "Get Automatic Updates on This Search". The search results are displayed in a list format, with the first four results visible. Each result includes a thumbnail image, a title, a ScienceCinema rating, and a brief description. On the left side, there is a sidebar with "RESULT TOPICS" and "All Results (45)" listed. On the right side, there are two informational boxes: "WIKIPEDIA" and "EUREKA!ERT!". The bottom of the page shows a browser status bar with an "Error on page." message and a "100%" zoom level.

2,158 top results from at least 43,901 found.  
81 of 81 collections complete

Home | About | News | Advanced Search | Contact Us | Site Map | Help

Search: Full Text: laser cooling [Get Automatic Updates on This Search](#) | My Selections (0) | Clear Selections | Alerts | Print Results | Email Results | Collection Status

Papers (2113) Multimedia (45) **Translate Results**

Results 1 – 10 of 45 Sort by: Rank Limit to: All Collections 1 2 3 4 5 Search

**1 Frontiers in Laser Cooling, Single-Molecule Biophysics and Energy Science: Leo Hollberg and Allen Mills**  
ScienceCinema [4 stars]  
Leo Hollberg and Allen Mills present a talk at Frontiers in Laser Cooling, Single-Molecule Biophysics and Energy Science, a scientific symposium honoring Steve Chu, director of Lawrence Berkeley National Laboratory and recipient of the 1997 Nobel Prize in Physics. The symposium was held August 30, 2008 in Berkeley.

**2 Frontiers in Laser Cooling, Single-Molecule Biophysics and Energy Science: Wolfgang Ketterle**  
ScienceCinema [4 stars]  
Wolfgang Ketterle presents a talk at Frontiers in Laser Cooling, Single-Molecule Biophysics and Energy Science, a scientific symposium honoring Steve Chu, director of Lawrence Berkeley National Laboratory and recipient of the 1997 Nobel Prize in Physics. The symposium was held August 30, 2008 in Berkeley.

**3 Frontiers in Laser Cooling, Single-Molecule Biophysics and Energy Science: Carl Wieman**  
ScienceCinema [4 stars]  
Carl Wieman presents a talk at Frontiers in Laser Cooling, Single-Molecule Biophysics and Energy Science, a scientific symposium honoring Steve Chu, director of Lawrence Berkeley National Laboratory and recipient of the 1997 Nobel Prize in Physics. The symposium was held August 30, 2008 in Berkeley.

**4 Frontiers in Laser Cooling, Single-Molecule Biophysics and Energy Science: Dave Weiss**

**WIKIPEDIA**  
**Laser cooling**  
Laser cooling refers to the number of techniques in which atomic and molecular samples are cooled through the interaction with one or more laser light fields. The first example of laser cooling, and also still ...

**EUREKA!ERT!**  
Piece of cake: Arrays of long nanotubes may help measure terahertz laser power  
Terahertz radiation can penetrate numerous materials -- plastic, clothing, paper and some biological tissues -- making it an attractive candidate for applications such as concealed weapons detection, package inspection ...  
NIST mechanical micro-drum cooled to quantum ground state  
Scientists from the National Institute of Standards and Technology have demonstrated a flexible, broadly usable technique for steadily calming the vibrations of an engineered

Error on page. Internet 100%

By using the speech-recognition search technology made possible through ScienceCinema (via MAVIS), the ability to search for multimedia information through portals like WorldWideScience.org vastly extends the availability and accessibility of multimedia science information. ScienceCinema, by enabling easy access to multimedia science information, maximizes the use of DOE and CERN research results, which could ultimately lead to new breakthroughs and benefits to the scientific community.