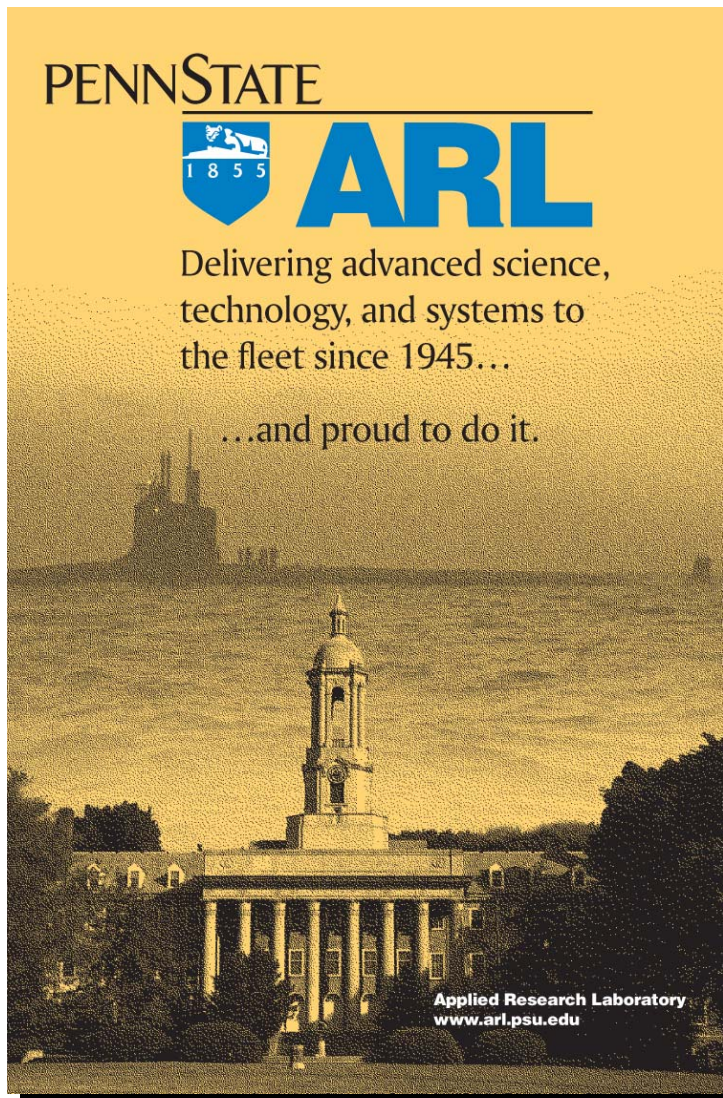


Applied Research Laboratory: Visualization, Information and Imaging Programs

Dr. Christopher Griffin
Applied Research Laboratory
Penn State University



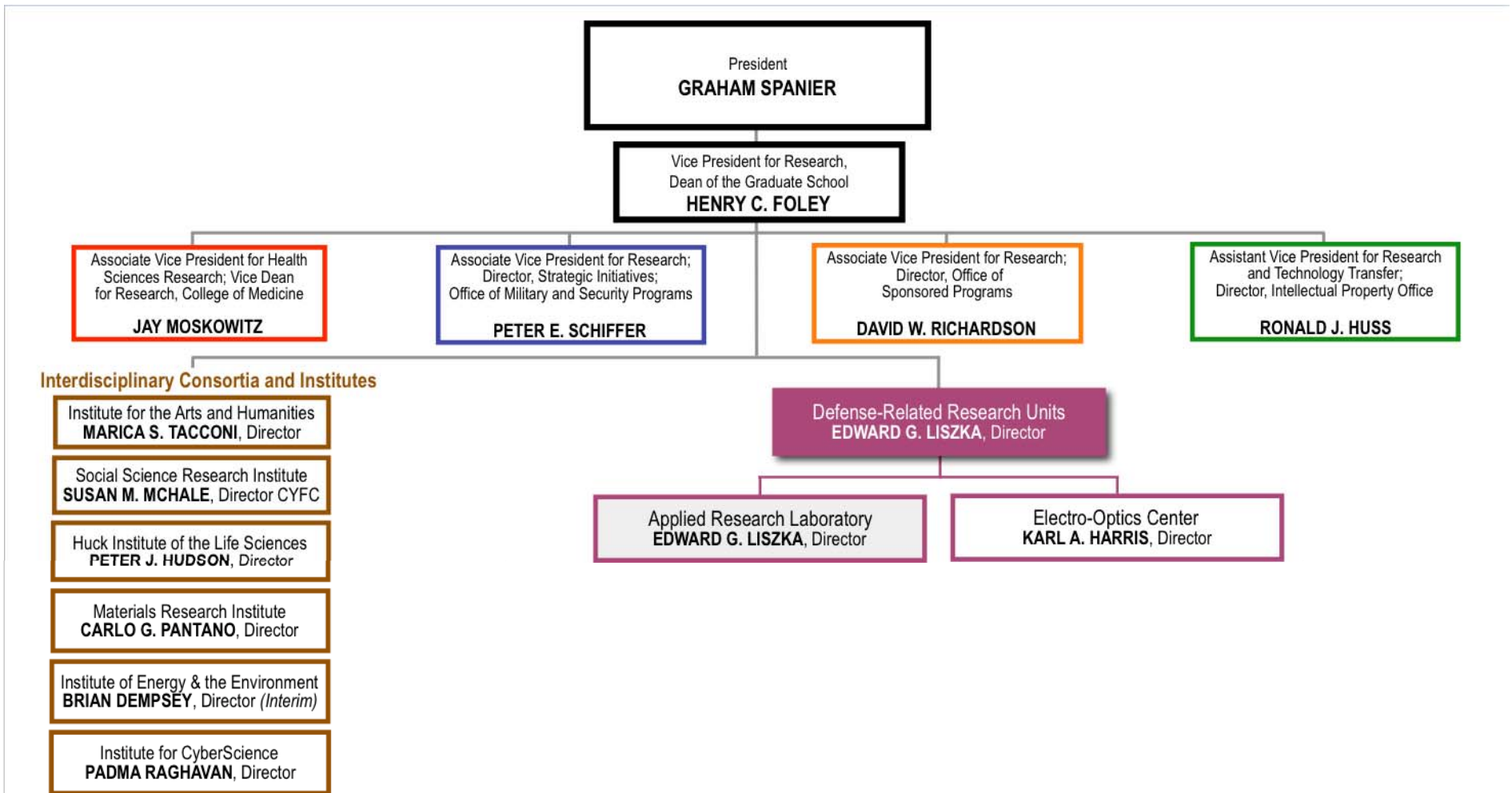
As a DoD designated University-Affiliated Research Center (UARC) ARL Penn State...

- “...maintains a special long-term strategic relationship with Navy and DoD.”
- We have the freedom to partner with multiple organizations in responding to BAA’s or other government calls.
- We can act as a trusted agent of the government.

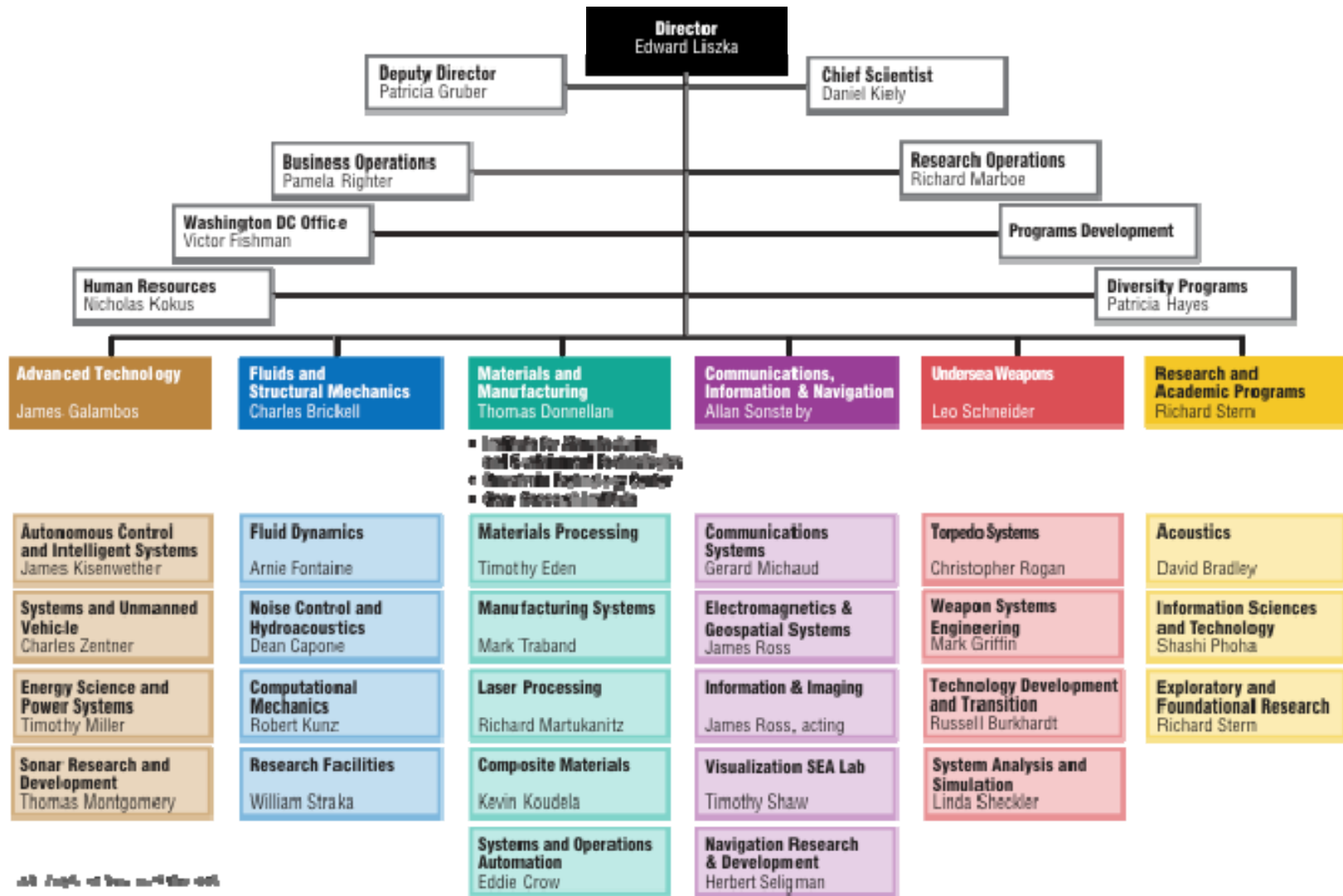
ARL also maintains special relationships with the Intelligence Community

- ARL maintains 12,000 square feet of SCIF space.
- Classified computing networks
- Classified phone networks

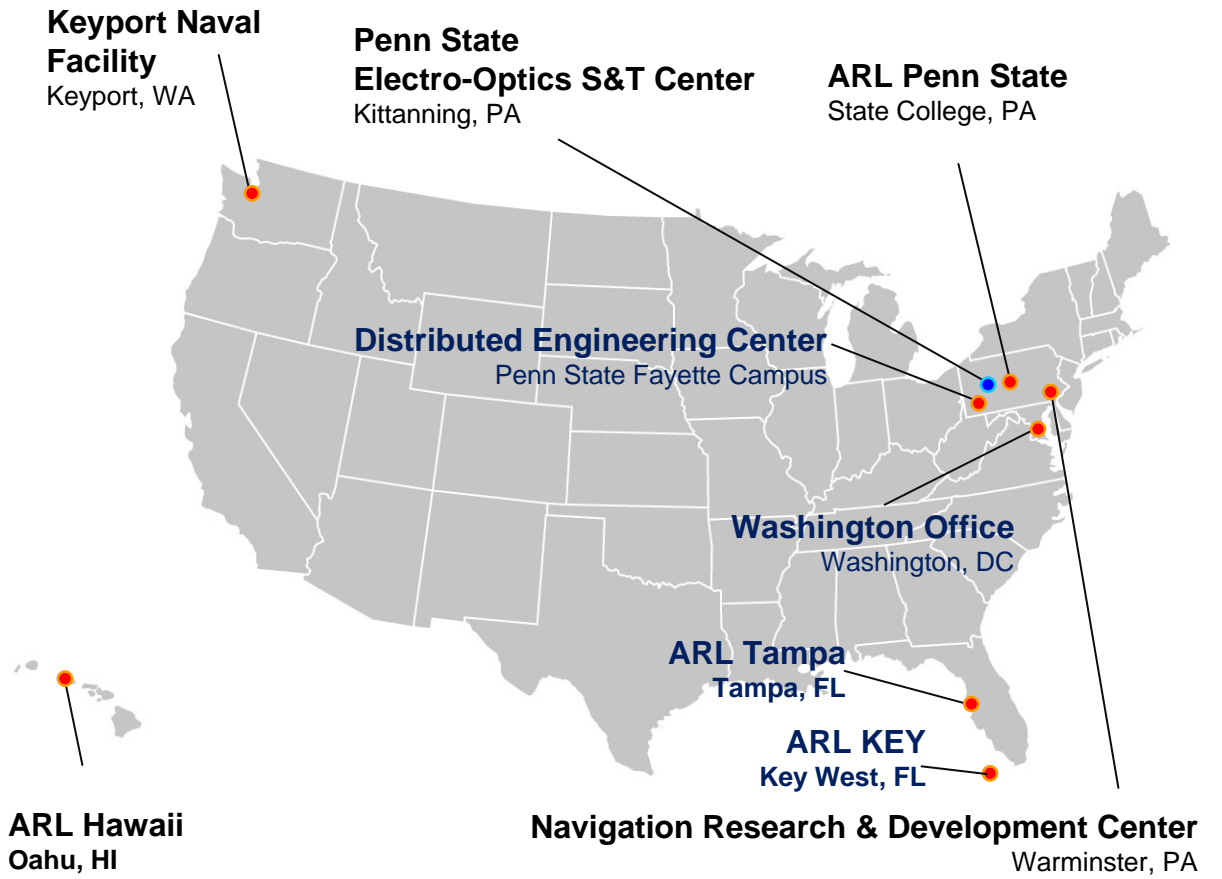
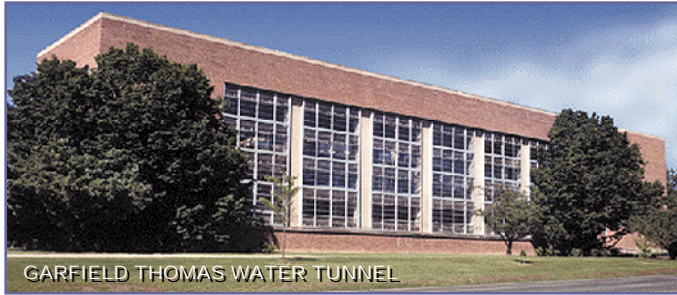
How ARL Fits into the University?



How is ARL Organized?



Applied Research Laboratory Locations and Offsite Activities



VISUALIZATION SEA LAB



Visualization Programs and Our Unique Relationship with Law Enforcement



SOUTHCOM
 - Battlelab at Key West
 - J2*

DTRA
 - DEL

JFCOM
 - JIL

Customer
 - Advanced Futures Lab

JIEDDO
 - COIC*

PSUARL
 - SEA Lab
 - SEA Wall
 - SEA Tap

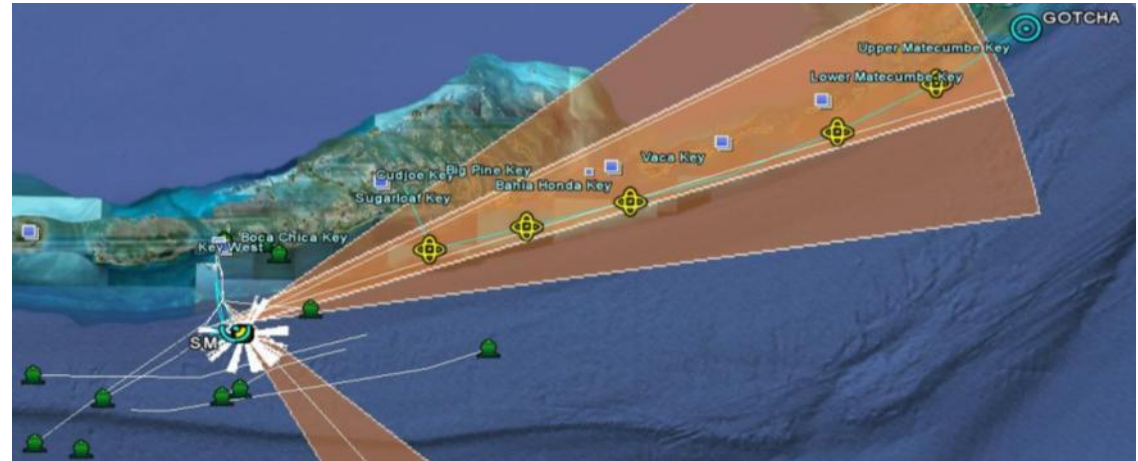
Customer
 - N. VA Area



Tactics and Planning (TAP) Table

Small group collaboration tool

- Multi-touch/gesture activated surface
- Geospatial visualization/data correlation
- Real-time distributed collaboration

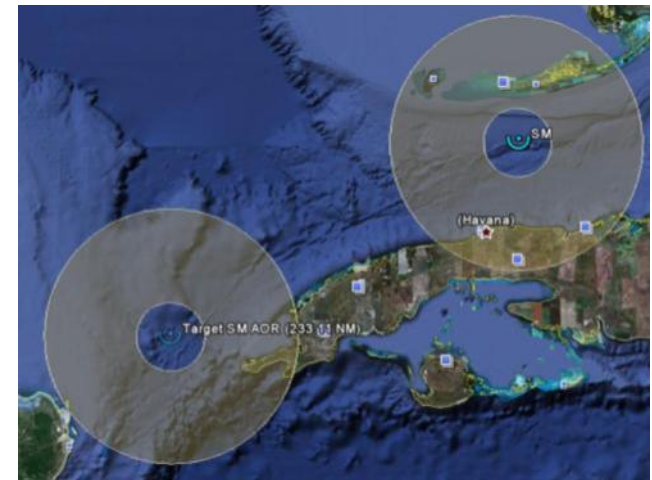


Real-time correlated data feeds for situational awareness

- Force laydown and status
- Target tracks and Intel
- Weather
- Logistics

Command and Control (C2)

- Intuitive user interface to task sensor platform to fill collection gap



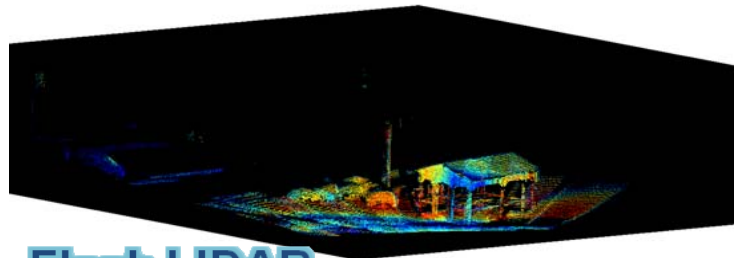
Providing intelligence, operations, and support personnel a means to collaboratively interact with an integrated Common Operational Picture (COP)

INFORMATION AND IMAGING

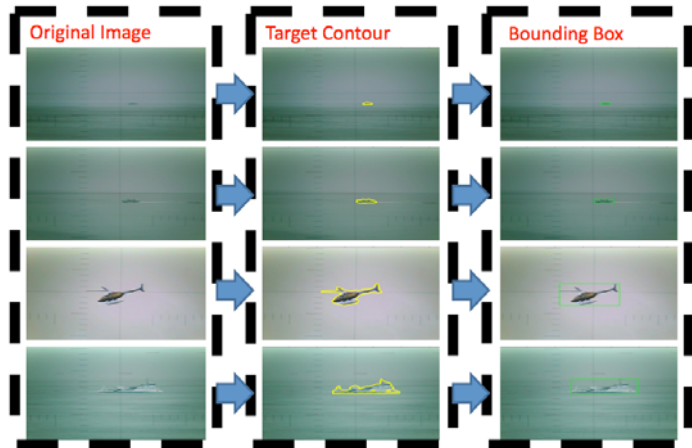
Information and Imaging Division: An ARL Basic Research Division

Information and Imaging Division

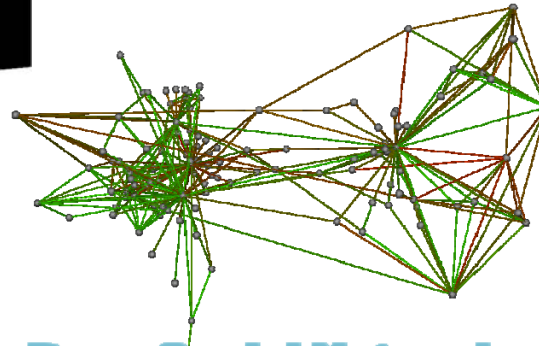
- Algorithms for understanding systems from kinematics, text, images, video and audio (*modeling*)
- Algorithms for predicting systems from kinematics, text, images, video and audio (*prediction*)
- Algorithms for controlling systems with kinematics, text, images, video and audio (*control*)



Flash LIDAR



Periscope Image Analysis

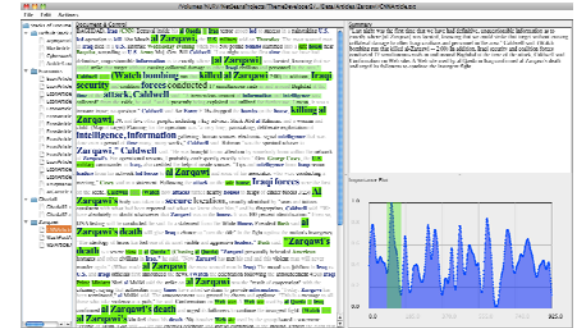


Deep Social Network Analysis

SAMPLE PROJECTS

UNCLASSIFIED//FOUO

Large Scale Statistics for Neutron Science



Automated Text Analysis

INFORMATION PROGRAMS

ARL Theme Developer

The Summarizer interface displays a document with highlighted text in Spanish and English. The summary section contains the following text:

La esposa de Clinton, la secretaria de Estado Hillary Rodham Clinton, había viajado desde Washington a Nueva York para acompañar a su esposo en el hospital. Salió del hospital a eso de las 11:30 de la noche sin formular declaraciones.

Tres camionetas con las ventanas oscurizadas entraron a eso de las 7:45 a.m. a la casa de los Clinton en Chappaqua, una población del condado de Westchester, a unos 56 kilómetros (35 millas) al norte de Nueva York.

Douglas Band, asesor de Clinton, emitió un comunicado informando que Clinton fue dado de alta del Hospital Presbiteriano de Nueva York en Manhattan "en excelente estado de salud".

Horas antes otro allegado, el ex presidente del Comité Nacional Demócrata Terry McAuliffe, le había dicho a la cadena de televisión CBS que Clinton había sido dado de alta del hospital tras ser sometido a una angioplastia.

Clinton "está ansioso por retomar sus labores en su fundación, y por seguir su trabajo a favor de las labores de ayuda y reconstrucción de Haití", dice el comunicador.

Horas antes otro allegado, el ex presidente del Comité Nacional Demócrata Terry McAuliffe, le había dicho a la cadena de televisión CBS que había sido dado de alta del hospital tras ser sometido a una angioplastia.

"Salió del hospital" y se encuentra en el automóvil camino de Nueva York.

"Y como conozco al presidente Clinton, estará en el teléfono ... pidiendo ayuda para Haití y donde puede obtener camionetas para distribuir los alimentos generadores. Como conozco a Bill Clinton, estará dispuesto a ir en 35 minutos".

The importance plot shows a line graph with a peak around 0.82. The message distribution chart shows a grid of blue dots representing various messages over time, with labels like "Food critical" and "Water is most critical asset".

- POS/Synonyms etc.
- Negation detection
- Key meme detection and highlighting
- Auto-summarization
- Multi-lingual support
- Multi-document summarization
- External data source hyper-linking
- Topical projection into a graph
- Information spectrogram
- Topical extraction
- Automated document clustering

The Topic Model interface displays a network graph with nodes and edges. The nodes are labeled with terms like "Columbia", "Washington", "Hillary Clinton", "ONU", "CNN", "ayuda", "hospital", "de Nueva York", "fue presidente de", "que", "ayuda", "le", "br", "ONU", "CNN", "Hillary Clinton", "Chelsea", "Washington", "Columbia". The graph shows a complex network of relationships between these terms.

The assessment text reads:

Assesment
El ex mandatario de EEUU fue nombrado el pasado año enviado especial del secretario general de la ONU, Ban Ki moon, para ayudar a la reconstrucción del empobrecido país antillano, y después del devastador terremoto del 12 de enero, le designó como coordinador de la ayuda internacional en favor de Haití. Durante sus dos mandatos, Bill Clinton demostró su interés en ayudar desde su posición al frente del Gobierno estadounidense a ese país y después, al dejar la Casa Blanca en 2001 ha ejercido una intensa actividad humanitaria desde la fundación que lleva su nombre en favor de ese país, mediante la recaudación de fondos y la canalización de inversiones para ayudar a su reconstrucción.

El doctor Alan Schwartz, cardiólogo de Clinton y quien le practicó ese procedimiento quirúrgico, ha señalado que el pronóstico de su paciente era "excelente" y que, de seguir así, podría volver a su actividad normal desde el próximo lunes.

Horas antes otro allegado, el ex presidente del Comité Nacional Demócrata Terry McAuliffe, le había dicho a la cadena de televisión CBS que Clinton había sido dado de alta del hospital tras ser sometido a una angioplastia.

Cuando el ex presidente de EEUU llegó a la Casa Blanca en 1992 se conoció su nación por la comida rápida, sobre todo por las

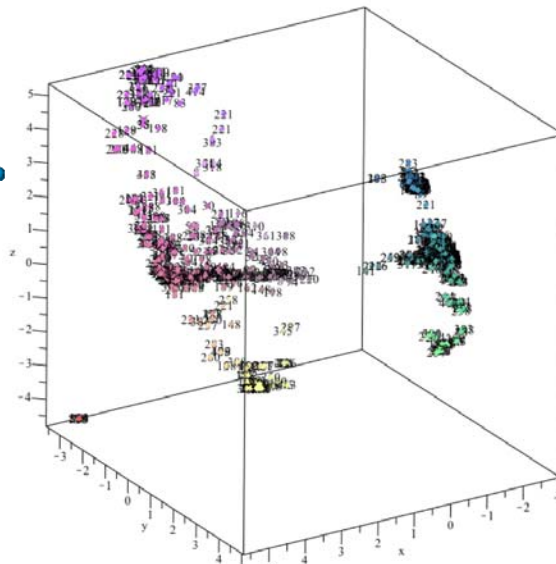
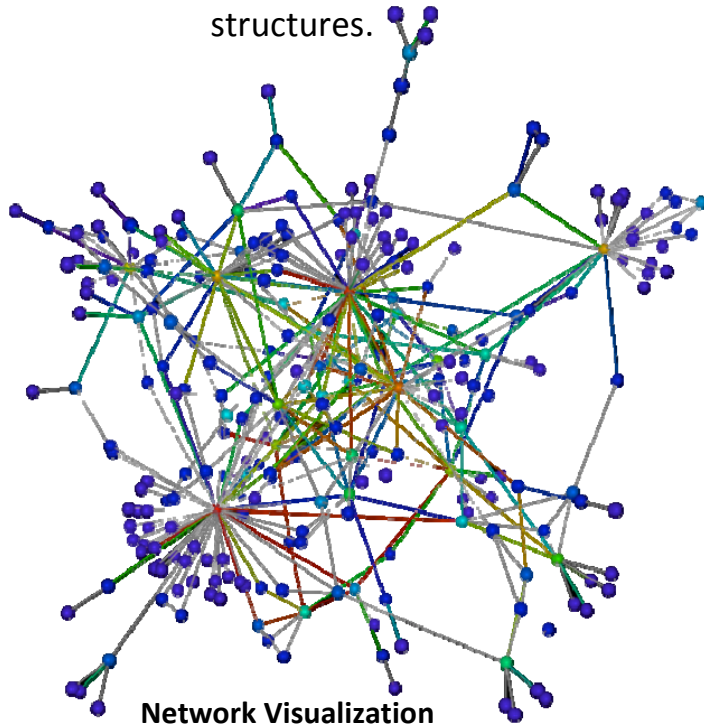
In tool analysis of Haiti Earthquake Data

UNCLASSIFIED//FOUO

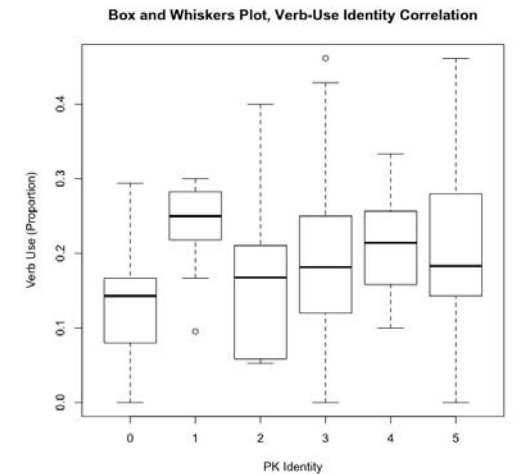
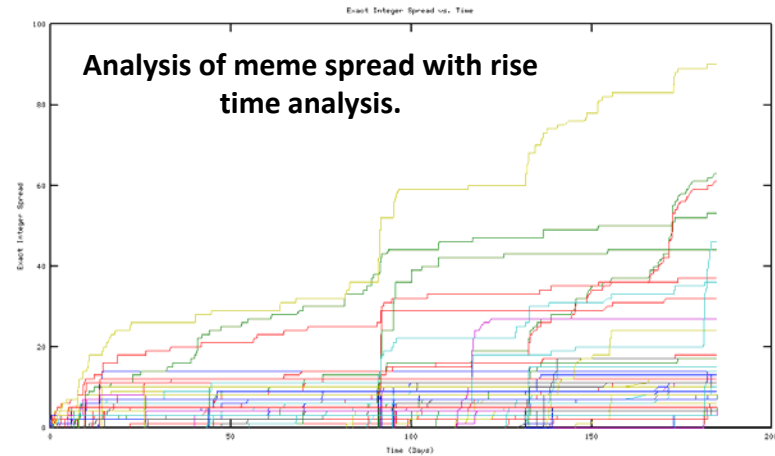
Deep Social Network Analysis

Deep Social Network Analysis

- Apply automated text mining techniques on the message internals
- Mathematical characterization of some social science theories as they apply to group interactions
- To achieve a scientifically grounded approach to using message internals to **augment** the analysis of social network structures.



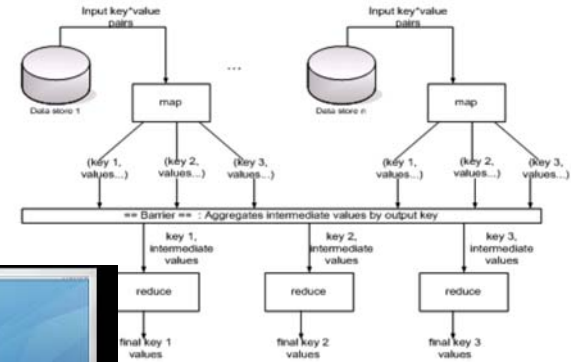
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Identify comparison through linguistic indicators (including sentiment analysis).

What's Next: High Performance Text Extraction and Analysis

- Next Steps
 - Increase computational power to process more messages faster.
 - Enhance model fidelity and incorporate human psychological factors more deeply into our mathematical models.
 - Take advantage of the power hybrid models can offer on high performance computing infrastructures.
- Our work in high performance data analysis for neutron scattering experiments (with Oak Ridge National Lab) has enabled us to become familiar with issues in HPC. Porting our text analysis systems to HPC hardware is now a priority:
 - Sponsor is providing a small cluster computing system (~1.25 TFLOPS)
 - ARL is building a cloud computing infrastructure to explore computation in this medium.



Cyber Security Graduate Students

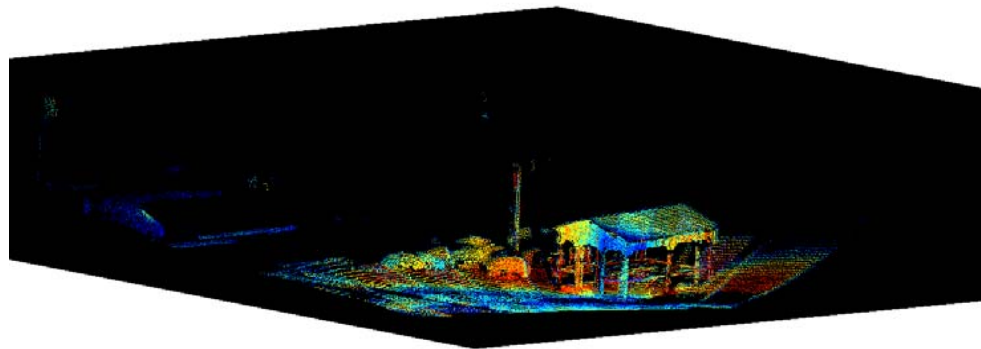
- ARL began a program of supporting graduate students to do novel work in the area of cyber-security.
- Currently three students are being funded.
- Work is broad ranging including computer science, mathematics and psychology.
 - Chosen to have a long-range impact on DOD cyber-security policy
 - Interesting and academically challenging problems were especially important in the selection process.
- Kurt Braddock (Dr. Horgan, Psychology): Typology of cyber-actors. Using modern criminological methods, Kurt is attempting to profile the behavior of cyber-criminals, terrorist and vigilantes to determine effective deterrence policy.
- Dan Keating (Dr. Liu, CSE): Insider threat in the cloud. Dan is using the current cloud computing infrastructure available within Dr. Liu's LION Lab to study the impact of insider threat in cloud computing applications.
- Jacob Turner (Dr. Morton, Math): Holographic Algorithms to investigate Shor's Algorithm. Using work by Valiant, Turner is investigating whether Shor's algorithm can be simulated in polynomial time on a classical computer.

IMAGING PROGRAMS



3D Flash LIDAR Imaging and Object Detection

- We are working with Flash LIDAR systems to develop real-time point cloud images of operating areas of interest.
- Unlike scanning LIDAR, a complete 3D image is returned in one shot. Color and dimensional information can be extracted.
- Change-point detection can be used for detecting objects of interest within the camera's field of view.

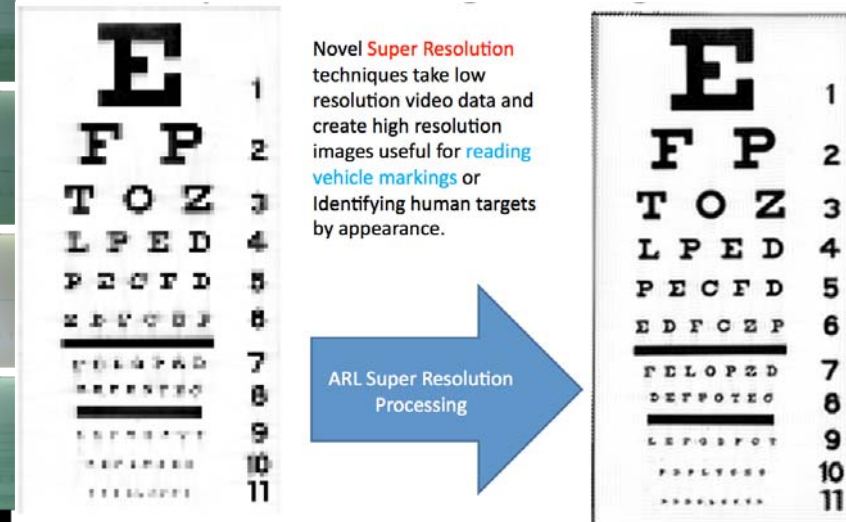
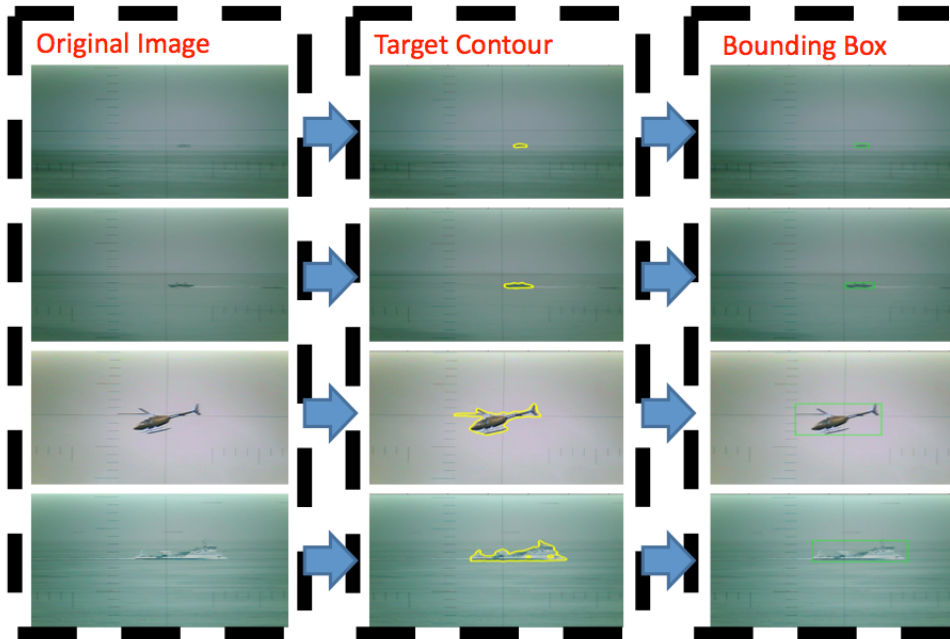


Flash Lidar 3D Point Cloud Change Detection



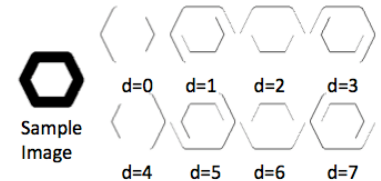
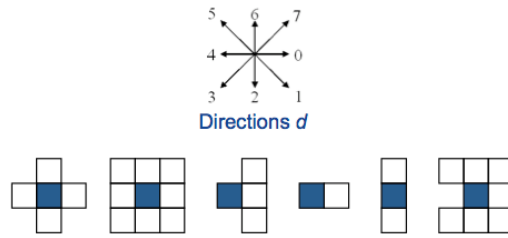
Image Segmentation and High Dynamic Range Super Resolution

- Our group has expertise in image segmentation methods.
- As a UARC we have worked on periscope programs to provide automated object detection and contouring.
- Our surveillance-specific HDR techniques allow images taken with varying exposure to be combined in such a way that the resulting image has an extremely high degree of detail, regardless of overexposed and underexposed regions in the image.
- We've developed novel super-resolution techniques useful for reading vehicle markings or identifying human targets.



Map Text Extraction and Recognition

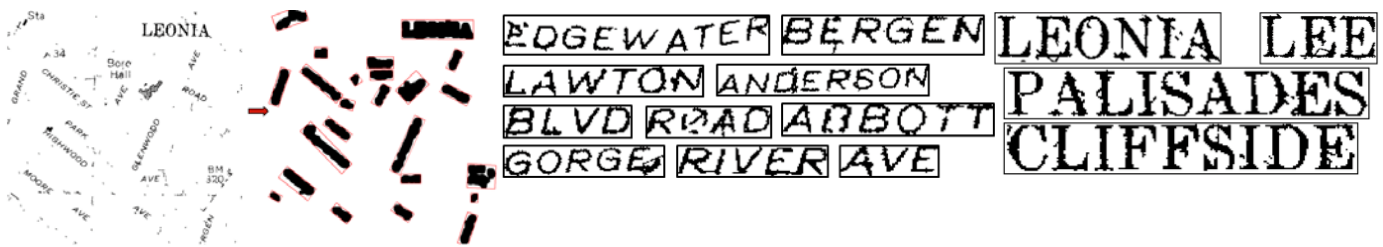
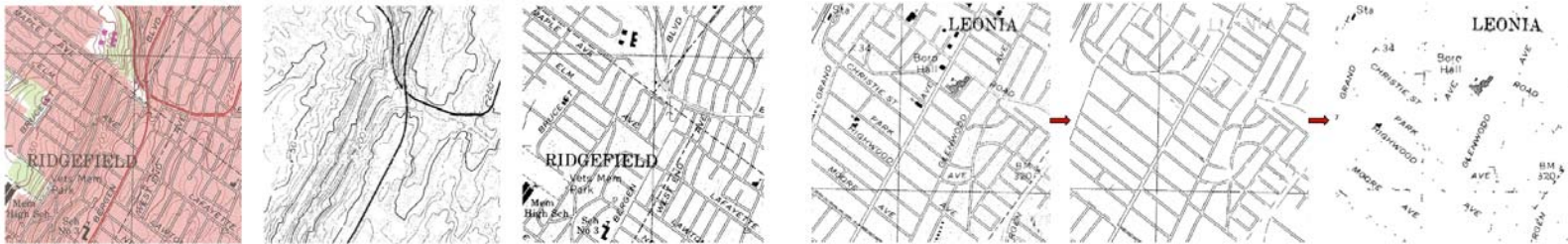
- Our group developed an automated map text extraction systems:
- Developed new line representation system using directional morphological operations that operate as directional edge detectors
- Lines with arbitrary curvature & orientation extracted correctly even when intersecting and passing through characters
- Developed custom character recognition engine and system to deal with rotated and skewed text.



Sample image & its corresponding directional edges

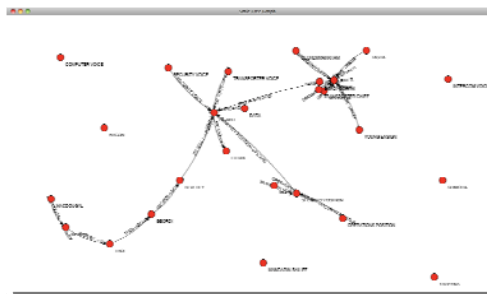
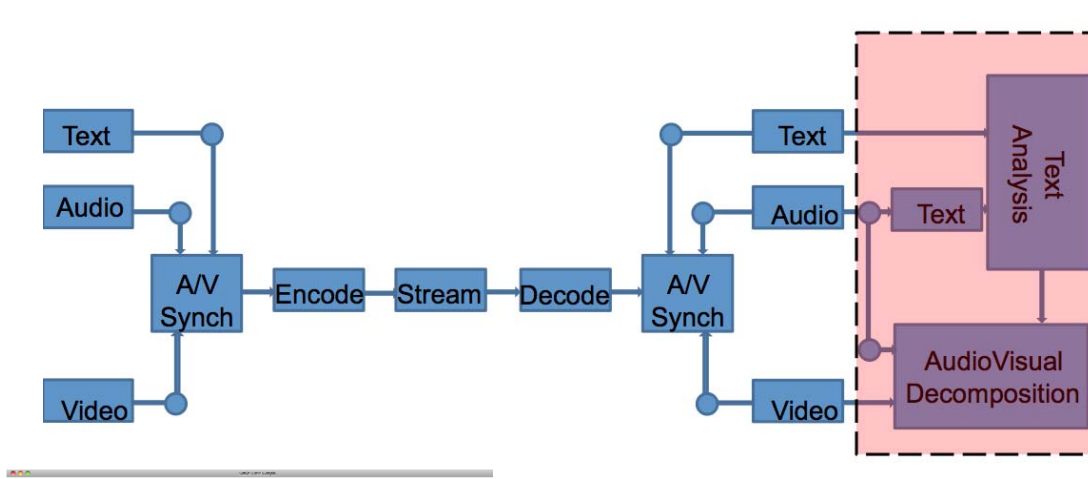
Non-directional Operators (4 & 8 neighbors) neighborhoods (a),(b)	
$D_{n4}f = f \cup (\cup_{d=0,2,4,6} f[d])$	$D_{n8}f = f \cup (\cup_{d=0}^7 f[d])$
$E_{n4}f = f \cap (\cap_{d=0,2,4,6} f[d])$	$E_{n8}f = f \cap (\cap_{d=0}^7 f[d])$
Fan Directional Operators (neighborhood (c))	
$D_{>d}f = f \cup (\cup_{i=d+3}^{d+5} f[i])$	$E_{>d}f = f \cap (\cap_{i=d-1}^{d+1} f[i])$
Single Directional Operators (neighborhood (d))	
$D_{=d}f = f \cup f[d+4]$	$E_{=d}f = f \cap f[d]$
Directional Operators orthogonal to d (neighborhoods (e),(f))	Macro Operators
$D_{=d}f = D_{=d-2}f \cup D_{=d+2}f$	$Open f = D(Ef)$
$D_{>d}f = D_{>d-2}f \cup D_{>d+2}f$	$Close f = E(Df)$
$E_{=d}f = E_{=d-2}f \cap E_{=d+2}f$	$End f = f \cap E_{>d}f$
$E_{>d}f = E_{>d-2}f \cap E_{>d+2}f$	
Masked Operations	Iterative Application
$D_{,g}f = g \cap Df$	$D^2 f = D(Df)$
$E_{,g}f = E(f \cup g)$	$E^3 f = E(E(Ef))$
$Open_{,g}f = D_{,g}(Ef)$	$Open_{>d,g}^m f = D_{>d,g}^m E_{>d}^m f$
$Close_{,g}f = E(D_{,g}f)$	$Close_{>d,g}^m f = E_{>d}^m D_{>d,g}^m f$
$D_{,,}f = f \cap Df$	

Set of basic Multi Angled Parallelism operators

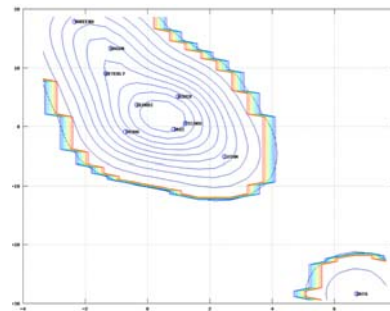


What's Next: Combined Audio / Video / Text Analysis

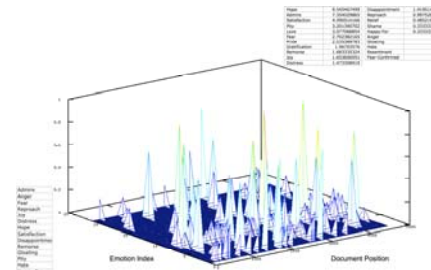
- We're now beginning to work on programs that involve the fusion of text, video and audio analysis.
- The goal of this program is to show that each analytic process can cross-inform the other, helping to reduce error and noise.
- We envision a product that extracts audio from movie files and transforms it to text. This text can then be analyzed.
- Information from the text analysis informs an image recognition problem and identifies key parts of the video.
- Information from image recognition can then back inform text analysis and help reduce audio to text translation.



Hierarchy / Role Detection



Actor Speech Analysis



Emotion Detection



Image / Text Cross Correlation

- *ARL Penn State has a 65-year proud legacy of delivering advanced technology and R&D products to the national defense*
- *The UARC designation captures our trusted agent status and the strategic relationship that exists between Penn State and the DoD*
- *Our “track record” is based upon a first principles “systems engineering” research approach*
- *ARL fulfills a key role in developing a cadre of engineers and scientists needed for the future defense and IC workforce*
- *We are working on programs that are critical to current forces and their future capabilities*