Bilkent University Computer Engineering Department

MSc and PhD Programs

Prof. Dr. H. Altay Güvenir

Graduate Programs

- **MSc**
  - 8 courses + Seminar + Thesis
- **PhD**
  - With MSc degree (approx. 4 years)
    - 8 courses + Seminar + Thesis
  - With BSc degree (approx. 5 years)
    - 16 courses + 2 Seminars+ Thesis

Applications

- Application Deadline: 4 June 2012
- Online Application:
  https://stars.bilkent.edu.tr/gradapp/
- Requirements for application:
  - CGPA ≥ 2.80 / 4.00
  - ALES (Türk adaylar) or GRE (Foreign applicants)
    - ALES: Quantitative ≥ 55 (for MSc), 70 (for PhD)
    - GRE: Quantitative + Verbal ≥ 295 (MSc), 305 (PhD)
  - English Proficiency: TOEFL (IBT) ≥ 82 or IELTS ≥ 6.5 or KPDS ≥ 87 or ÜDS ≥ 87.

Interview

- **Date:** 11-12 June 2012
- **Hard copy documents to be submitted during interview:**
  - Transcript
  - ALES or GRE score report
  - Reference letters (2)
  - Proof of English Proficiency (TOFLE, IELTS, KPDS or ÜDS report)

Acceptance requirements

- At least one faculty member willing to work with the applicant
- Department approval
- Graduate School of Engineering and Science approval

Ways of acceptance

- **Department scholarship**
  - Tuition waiver
  - Stipend
  - Accommodation
  - Health Insurance
  - Additional Scholarship for Teaching Assistantship
  - Office (shared)
- **TÜBİTAK Scholarship, TÜBİTAK projects**
  - Tuition waiver
  - Accommodation
  - Health Insurance
  - Teaching Assistantship (no payments)
  - Office (shared)

Ways of acceptance

- **Project grants (except TÜBİTAK projects)**
  - Tuition waiver
  - Stipend (paid from the project budget)
  - Accommodation
  - Health Insurance (paid from the project budget)
  - Additional Scholarship for Teaching Assistantship
  - Office (shared)
- **Graduate School scholarship**
  - Tuition waiver
  - Additional Scholarship for Teaching Assistantship

Faculty Members

- In alphabetic order

  (Please contact with them in person for details)

Varol Akman (akman@bilkent.edu.tr)

- **Doğal dilde anlam ve kullanımla ilgili sorunların — özellikle bağlamın katkılarının — bilgisayar programları yazarak irdelenmesi**

- **Yapay zekanın — özellikle sağduyunun — mantıksal temelleri ve bunların bilgisayarda gösterimi**

- **İnternetin toplumu ilgilendiren yönleri**

Dil Felsefesi

Yapay Zeka

Akıl Felsefesi

Selim Aksoy

saksoy@cs.bilkent.edu.tr
http://www.cs.bilkent.edu.tr/~saksoy
Office: EA 423 (4th floor)

Research interests:
- Computer vision
- Pattern recognition
- Machine learning
- Data mining

Current topics:
- Remote sensing image analysis
- Image and video mining
- Medical image analysis

RETINA Vision and Learning Group
http://retina.cs.bilkent.edu.tr

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Sponsored Research Projects

- Remote sensing image analysis
  - TÜBİTAK CAREER Grant, 158,000 YTL, 2005-2010
  - EC Joint Research Centre, 35,000 Euro, 2008
  - FP6 Marie Curie Grant, 80,000 Euro, 2005-2007
  - U.S. Army, $850,000, 2003-2005
  - NASA Goddard Space Flight Center, $430,000, 2001-2004
- Image and video mining
  - TÜBİTAK and COST 292 Action, 102,060 YTL, 2004-2008
  - DPT, 2004-2005
- Medical image analysis
  - TÜBİTAK CAREER Grant, 158,000 YTL, 2005-2010
  - U.S. National Library of Medicine, $750,000, 2001-2004

Dr. Selim Aksoy

Remote Sensing Image Analysis

➢ Increasing resolution in space and time (NASA receives 3 TB/day)

➢ Object recognition, classification and retrieval (Have you tried Google Earth?)
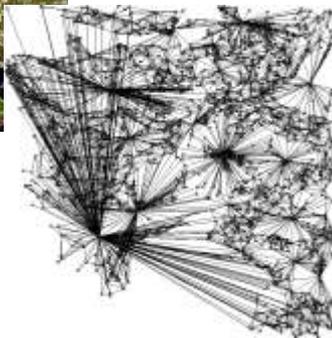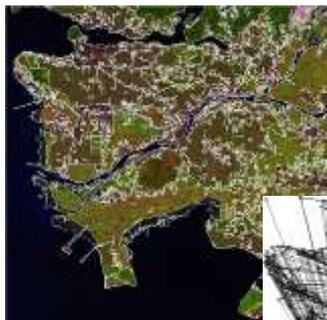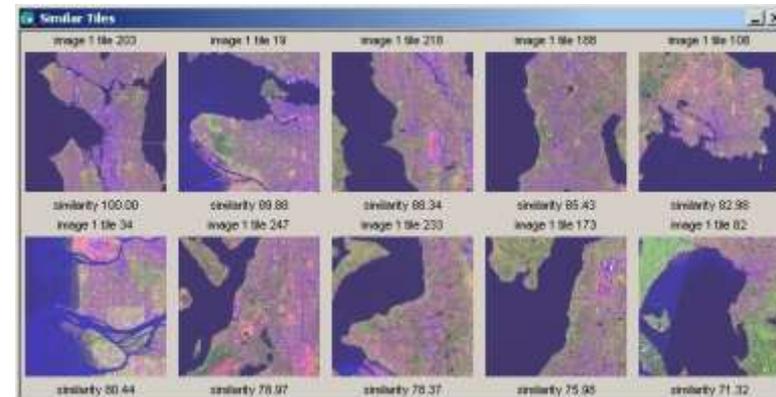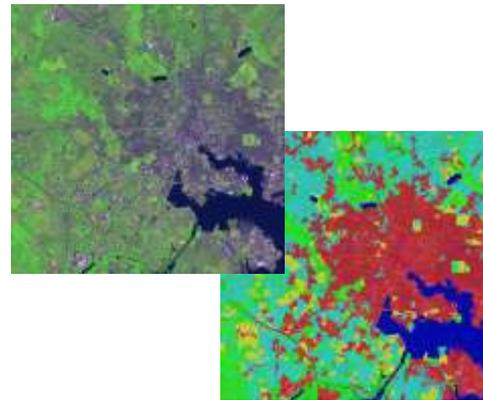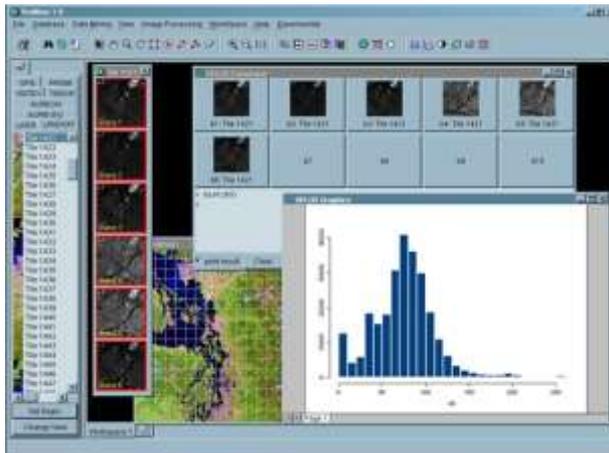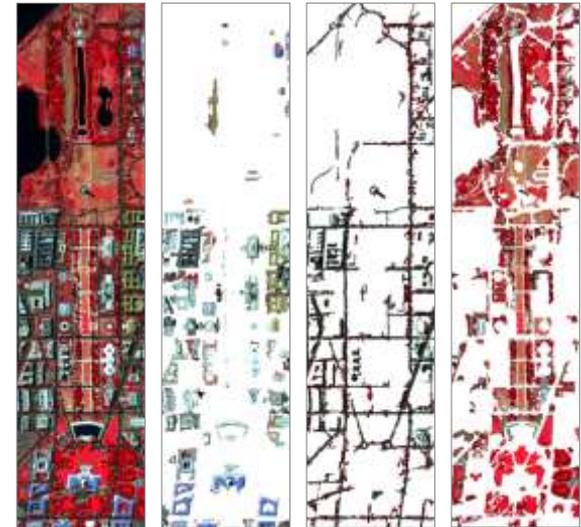
➢ Urban planning / monitoring

➢ Effects of natural disasters

➢ Environmental monitoring

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Dr. Selim Aksoy

Image and Video Mining

➢ Huge amounts of multimedia data (personal, commercial, free, …)

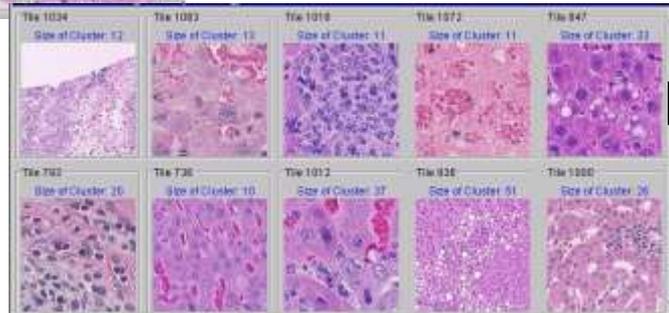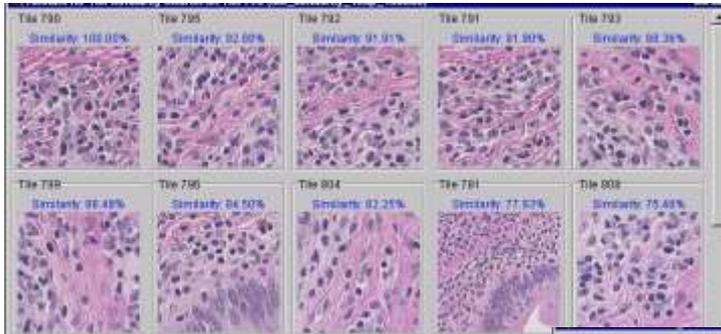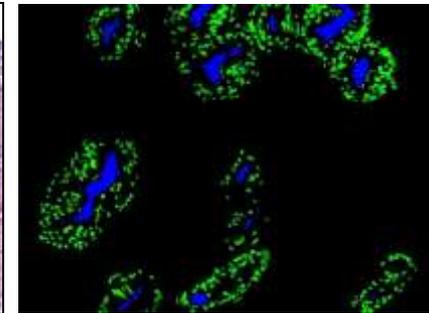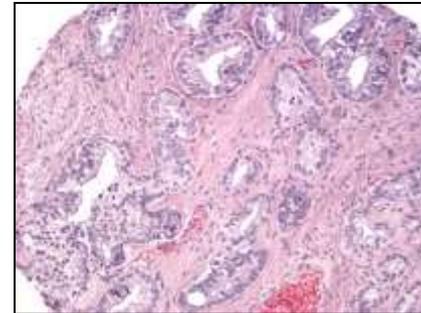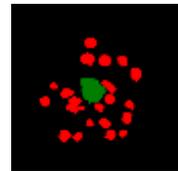➢ Semantic classification and retrieval (Have you tried Google Video?)
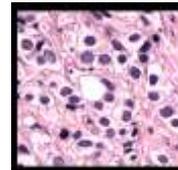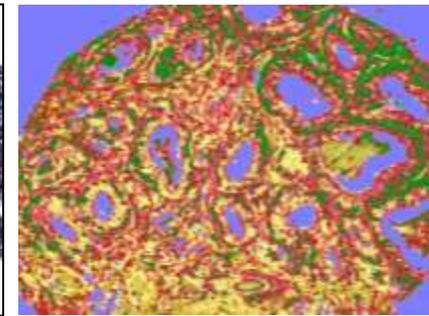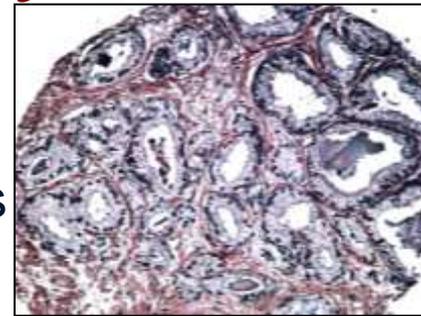
➢ Object recognition

➢ Scene classification

➢ Combining image/audio/motion/text

Dr. Selim Aksoy

Medical Image Analysis

- Microscopic image classification
- Cancer detection / grading
- Content-based searching of past cases
- Automatic report generation

Dr. Selim Aksoy

Can Alkan

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Lab for Bioinformatics and Computational Genomics
http://www.cs.bilkent.edu.tr/~calkan/compgen

Combinatorial algorithms to analyze high throughput sequence data to discover, genotype, and phase genomic variants, assemble genomes and transcriptomes.

Test genome

Random shearing and Size-selection

Paired-end sequencing

Resequencing

De novo sequencing
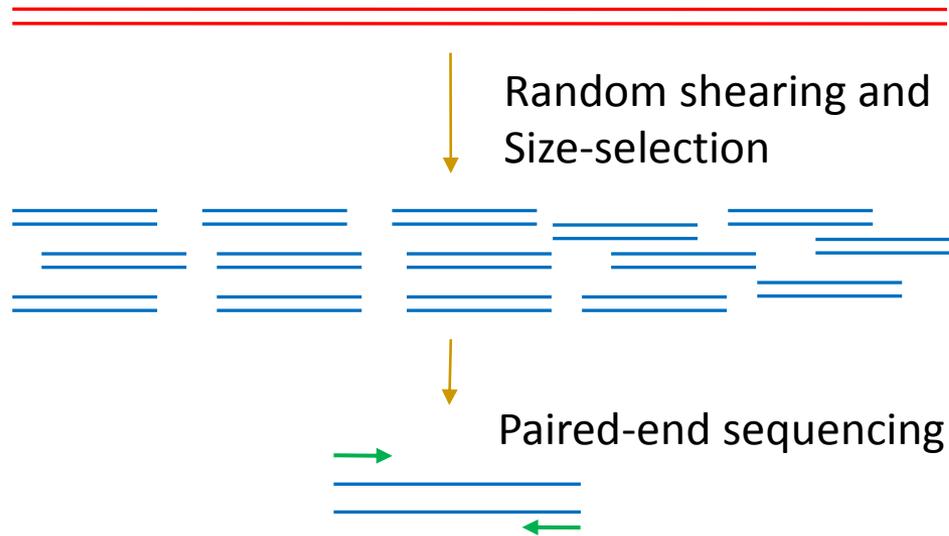
Reference Genome

Read mapping and variation analysis

Assembly

Contigs/ Scaffolds

Types of genomic variants

SNP: Single nucleotide polymorphism (substitutions)
Indel: Insertions and deletions of sequence of length 1 to 50 basepairs

reference: C A C A G T G C G C - T
sample: C A C C G T G - G C A T

SNP   deletion   insertion

Short tandem repeats: microsatellites, minisatellites, alpha & beta satellites, etc.

reference: C A G C A G C A G C A G
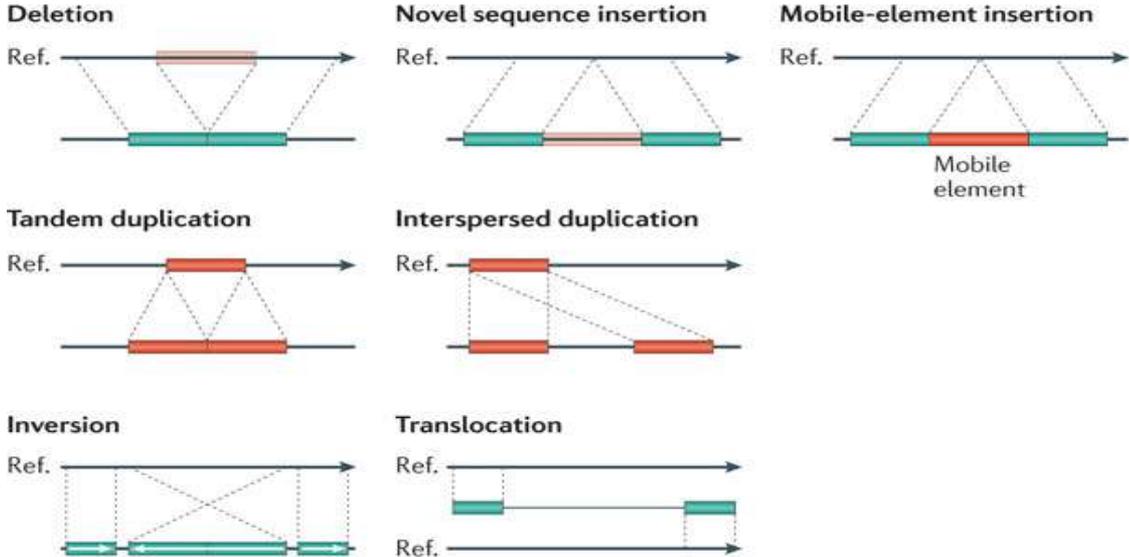*sample:* C A G C A G C A G C A G C A G

Structural variation:
Genomic alterations > 50 bp
Deletions, insertions, mobile elements, duplications, inversions and translocations

Deletion — Ref.

Novel sequence insertion — Ref.

Mobile-element insertion — Ref. / Mobile element

Tandem duplication — Ref.

Interspersed duplication — Ref.

Inversion — Ref.

Translocation — Ref. / Ref.

Genome sequencers

Roche/454
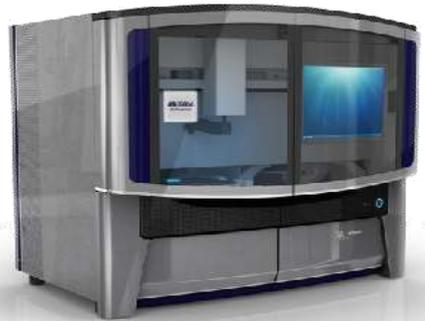
AB SOLiD

Illumina MiSeq

Complete Genomics

Illumina HiSeq2000

Pacific Biosciences RS

Oxford Nanopore MinION

Oxford Nanopore GridION

Ion Torrent PGM

Ion Torrent Proton

... and more! All produce data with different properties.

Selected publications

Personalized copy number and segmental duplication maps using next-generation sequencing. *Nature Genetics,* Oct, 41(10):1061-1067, 2009.
   * **Highlighted** in News and Views, "Mapping duplicated sequences", DY Chiang and SA McCarroll, *Nature Biotechnology,* Nov; 27(11):1001-2, 2009.

Combinatorial algorithms for structural variation detection in high throughput sequenced genomes. *Genome Research*, Jul, 19(7):1270-8, 2009.

Detection and characterization of novel sequence insertions using paired-end next-generation sequencing. *Bioinformatics,* May 15; 26(10):1277-83, 2010.

A draft sequence of the Neandertal genome *Science*, 7 May, 328 (5979):710-722, 2010.
   Recipient of the 2010 AAAS Newcomb Cleveland Prize.

mrsFAST: a cache-oblivious algorithm for short-read mapping. *Nature Methods*, Aug;7(8):576-7, 2010.

A map of human genome variation from population-scale sequencing. 1000 Genomes Project Consortium. *Nature*, Oct 28;467(7319):1061-73, 2010.

Genetic history of an archaic hominin group from Denisova Cave in Siberia. *Nature*, Dec; 468(7327):1053-1060, 2010.

Limitations of next-generation genome sequence assembly. *Nature Methods,* 8(1):61-65, 2011.
   * **Highlighted** in Commentary, "Assemblies: the good, the bad, the ugly", E. Birney, *Nature Methods*, 8(1):59-60, 2011.

Mapping copy number variation by population-scale genome sequencing. *Nature,* 470(7332):59-65, 2011.

Genome structural variation discovery and genotyping. *Nature Reviews Genetics,* May;12(5):363-76, 2011.

Sensitive and fast mapping of di-base encoded reads. *Bioinformatics*, Jul 15;27(14):1915-21, 2011.

Detection of structural variants and indels within exome data. *Nature Methods*, 9(2): 176-178, 2012.

Projects

- Discovery and characterization of genomic variation
  - Funded by EU Marie Curie Actions Career Integration Grant
- Algorithms and hardware designs for ultra-fast mapping of HTS reads to reference genome assemblies
  - Funded by US National Institutes of Health
- De novo and hybrid (multi-platform) sequence assembly.
- Genomic repeat discovery, classification and annotation.
- Distributed algorithms for genome assembly.

Positions available. Contact if you have B.Sc. or M.Sc. degree in computer science, computer engineering, electrical engineering, or mathematics, and if you are interested in combinatorial optimization, approximation algorithms, and graph theory. Strong programming skills in C/C++ are highly desired.

Successful applicants will also have a chance to contribute to many international consortiums such as the 1000 Genomes Project and the Genome 10K, and will involve in other international collaborations with researchers in Vancouver, Seattle, Barcelona, Bari, Pittsburgh, and more.

Basic understanding of biology/genetics/genomics is a *plus*, but **not required**.
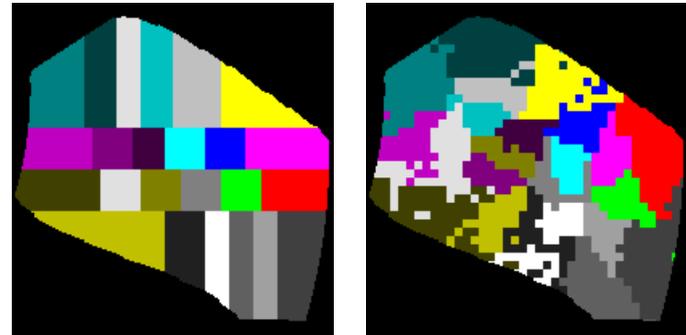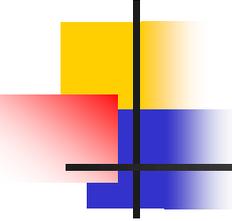
Parallel and Grid Computing Group

Prof. Dr. Cevdet Aykanat
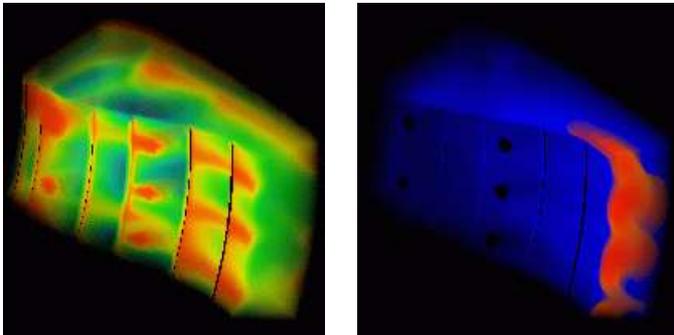
Volume rendering of a combustion chamber: pressure and velocity fields.


Screen assignments for 24 processors: jagged and hypergraph partitionings.

Paralel and Grid Computing Group

- **Projects funded by TUBITAK, Intel and European Union**

  - EU-funded FP6 SEE-GRID2 project (2006-2009)
  - Parallel Text Retrieval &Query Processing (TÜBİTAK, 2006-2008)
  - EU-funded FP6 EUMedGrid project (2006-2008)
  - EU-funded FP6 SEE-GRID project (SE4SEE application) (2004-2006)
  - Efficient Parallel Web Crawling (TÜBİTAK, 2004-2006)
  - Task scheduling for PC clusters (TÜBİTAK, 1999-2002)
  - Unstructured domain mapping (EU ITDC , 1995-1998)
  - Parallel direct volume rendering (TÜBİTAK EEAG, 1995-1997)
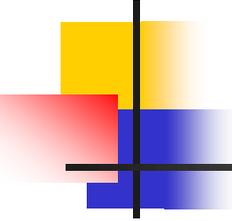 - Real-time realistic image generation (TÜBİTAK & Intel SSD,1991-1994)
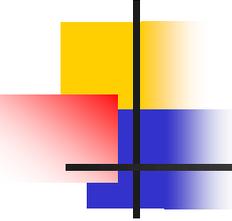
Paralel and Grid Computing Group

- Paralel computing architectures
  - Intel iPSC/2 hypercube (32 nodes)
  - Parsytec CC24 (24 nodes)
  - PC cluster (Borg) (32 nodes)
  - PC cluster (Skynet) (48 nodes)
  - Grid cluster (16 nodes)
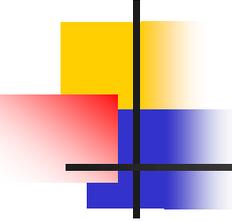
Paralel and Grid Computing Group

Paralel and Grid Computing Group

- **Current research topics**
  - Algorithm design for parallel and distributed computing applications
  - Parallel text retrieval, query processing
  - Parallel and distributed Web crawling
  - High-performance geographical information systems
  - Parallel scientific computing
  - Inverted index compression
  - Parallel and distributed data mining
  - Task allocation and scheduling for Grid systems
  - Grid-enabled Web search
  - Parallel direct volume rendering

Journal Publications (2006-2008)

1. C. Aykanat, B.B. Cambazoglu and B. Ucar, "Multi-level Direct K-way Hypergraph Partitioning with Multiple Constraints and Fixed vertices," **Journal of Parallel and Distributed Computing,** 2008.

2. T, Kucukyilmaz, B.B. Cambazoğlu, C. Aykanat, and F. Can, "Chat Mining: Predicting User and Message Attributes in Computer-Mediated Communication", **Information Processing & Management**, 2008.

3. A. Pinar, E.K. Tabak and C. Aykanat, "One-Dimensional Partitioning for Heterogeneous Systems: Theory and Practice," **Journal of Parallel and Distributed Computing**, 2008.

4. E. Demir, C. Aykanat and B. B. Cambazoglu, "Clustering Spatial Networks for Aggregate Query Processing, a Hypergarph Approach," **Information Systems**, 2008.

5. B. Ucar and C. Aykanat, "Revisiting Hypergraph Models for Sparse Matrix Partitioning," **SIAM Review**, 2007.

6. B. Uçar and C. Aykanat, "Partitioning Sparse Matrices for Parallel Preconditioned Iterative Methods," **SIAM Journal on Scientific Computing**, 2007.

7. B.B. Cambazoğlu and C. Aykanat, "Hypergraph-Partioning-Based Remapping Models for Image-Space-Parallel Direct Volume Rendering of Unstructured Grids," **IEEE Transactions on Parallel and Distributed Systems**, 2007.

8. K. Kaya, B. Uçar and C. Aykanat, "Heuristics for Scheduling File-Sharing Tasks on Heterogeneous Systems with Distributed Repositories," **Journal of Parallel and Distributed Computing**, 2007.

9. B.B. Cambazoğlu, E. Karaca, T. Kucukyilmaz, A. Turk and C. Aykanat "Architecture of a Grid-Enabled Search Engine, **Information Processing & Management**, 2007.

10. B. Uçar, C. Aykanat, M. Pınar and T. Malas, "Parallel Image Restoration Using Surrogate Constraint Methods," **Journal of Parallel and Distributed Computing**, 2007.

11. C. Aykanat, B. B. Cambazoğlu, F. Findik, and T.M. Kurc, "Adaptive Decomposition and Remapping Algorithms for Object-Space-Parallel Direct Volume Rendering of Unstructured Grids," **Journal of Parallel and Distributed Computing**, 2006.

12. B.B. Cambazoğlu and C. Aykanat, "Performance of Query Processing Implementations in Ranking-Based Text Retrieval Systems Using Inverted indices," **Information Processing & Management**, 2006.

13. K. Kaya and C. Aykanat, "Iterative-Improvement-Based Heuristics for Adaptive Scheduling of Tasks Sharing Files on Heterogeneous Systems," **IEEE Transactions on Parallel and Distributed Systems**, 2006.

14. B. Ucar, C. Aykanat, K. Kaya and M. İkinci, "Task Assignment in Heterogeneous Systems," **Journal of Parallel and Distributed Computing**, 2006.

Paralel and Grid Computing Group

- Contact information

  - Cevdet Aykanat
  - Phone: 312 290 1625
  - Email: *aykanat@.cs.bilkent.edu.tr*
  - Homepage: http://www.cs.bilkent.edu/~aykanat

INFORMATION RETRIEVAL GROUP BILKENT

Bilkent Information Retrieval Group

Faculty

Fazlı Can

Seyit Koçberber

Graduate Students

Cem Aksoy

Ceyhun Karbeyaz

Çagrı Toraman

Anıl Türel

Ahmet Yeniçağ

Undergraduate Students

Turgut Işık

Oğuz Kaya

Harun Özden

Abdullah Şahin

Volunteers

Aykut Bal

Akif Buğday

Bilge Köroğlu

Hasan Can Tuncay

Some Prev. Members

Erman Balçık

Ahmet Buğdaycı

Tunay Gür

Cihan Kaynak

Levent Koç

İbrahim Uysal

Other Contributors

Cevdet Aykanat

Pınar Duygulu

Özgür Ulusoy

İsmail Şengör Altıngövde

Özgür Bağlıoglu

Ethem F. Can

Gönenç Ercan

Süleyman Kardaş

H. Çağdas Öcalan

Erkan Uyar

Research Interests

- New Event Detection and Tracking
- Novelty Detection
- Information Retrieval
- Information Filtering
- News Categorization
- Text Mining &Processing

Bilkent News Portal

You are the right person for our group

- If you are good at four core practices of CS
  - programming,
  - systems thinking,
  - modeling, and
  - innovation.
- If you
  - "can dream,"
  - "can do," and
  - "can write."

Asst. Prof. Tolga Çapın
http://www.cs.bilkent.edu.tr/~tcapin

Interactive Computer Graphics
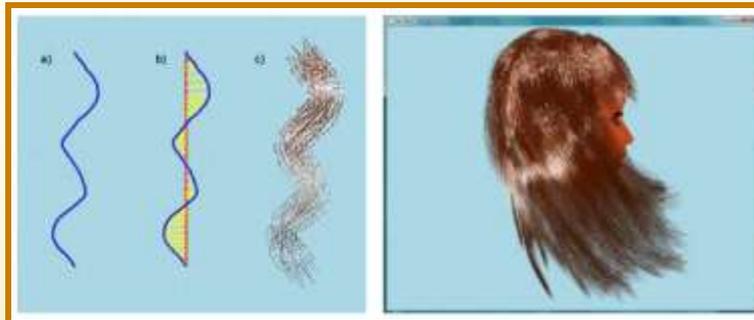
Computer Animation

- <u>Research Goal:</u> How can we represent virtual humans in interactive apps?
  - How can we animate avatars in games / VR?
 - How can we make use of motion capture?

Figure 5 a, b, c, d: The 4 elements used in the construction of body.

Aras, Basarankut, Ozguc. 2008. 3D Hair sketching for real-time dynamic & key frame animations. *Vis. Comput.* http://dx.doi.org/10.1007/s00371-008-0238-8

I. Pandzic, C. Babski, T. Çapın, et al., *Simulating Virtual Humans in Networked Virtual Environments*, The Journal of Presence: Teleoperators and Virtual Environments, MIT Press, **10(6),** 632-646 (2001). http://dx.doi.org/10.1162/105474601753272871
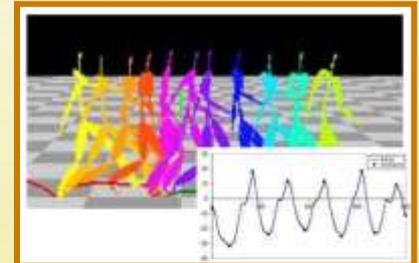
Cihan Halit and Tolga Capin. 2011. Multiscale motion saliency for keyframe extraction from motion capture sequences. *Comput. Animat. Virtual Worlds (*2011), http://dx.doi.org/10.1002/cav.380

Perceptually Driven Graphics

- Research Goal: How we can make use of human perception in graphics & displays?

  - How can a computer model human attention?
  - How can we measure the 3D graphics quality?

Abdullah Bulbul et al. 2010. Saliency for animated meshes with material properties. *Proceedings of Applied Perception in Graphics and Visualization* (APGV '10). ACM, New York, NY, USA, 81-88. http://dx.doi.org/10.1145/1836248.1836263
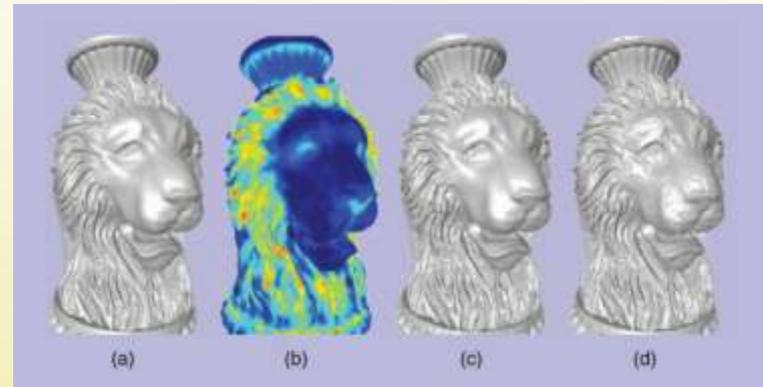
Abdullah Bulbul, Tolga Capin, Guillaume Lavoué, Marius Preda, Assessing Visual Quality of 3-D Polygonal Models, IEEE Signal Processing Magazine, IEEE Press, **28(6)**, 80-90 (2011). http://dx.doi.org/10.1109/MSP.2011.942466
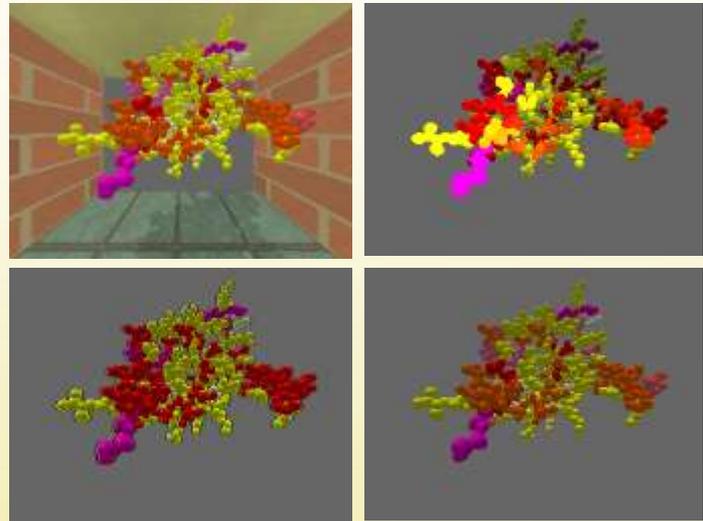
3D Rendering

- <u>Research Goals:</u>
  - How can we add artistic / perceptual styles for 3D display of graphical models?
  - How to use 3DTV / stereo displays efficiently?
  - How to make efficient use of 3D depth cues?

Sami Arpa, Abdullah Bülbül, Tolga Çapın, Bülent Özgüç, Perceptual 3D Rendering based on Principles of Analytical Cubism, to appear, 2012.

Z. Çipiloğlu, A. Bülbül, T. Çapın, A Framework for Enhancing Depth Perception in Computer Graphics, *Proceedings of the ACM APGV 2010*, Los Angeles, CA, USA, ACM Press, July 2010.
http://doi.acm.org/10.1145/1836248.1836276

Mobile Graphics

- Research Goal: How can we interact with 3D graphics on mobile displays?
  - How can we build a mobile phone with everything in 3D? (with stereo display, 3D camera, 3D apps)
  - How can we build 3D interaction techniques? (e.g. 3DUIs, 3D gestures)

Gotchev, A.; Akar, G.B.; Capin, T.; Strohmeier, D.; Boev, A.; , "Three-Dimensional Media for Mobile Devices," *Proceedings of the IEEE* , vol.99, no.4, pp.708-741, April 2011 http://dx.doi.org/10.1109/JPROC.2010.2103290

Sponsored Projects

- *3DPHONE – An All-3D Imaging Phone –* European Commission's FP7 STREP Project (Grant no: FP7-213349), Coordinator / Principal Investigator.

- *ALGI – TÜBİTAK 1001 Project (Grant no: 110E029),* Principal Investigator.

- *3DTV –* European Commission's FP6 NoE Project, Researcher.

- Various Nokia-internal projects related to mobile graphics and user interfaces, 2000-2006.

- Played a key role in setting up European Projects: SoNG, VIDAS, and FIVE. Role: Workpackage Leader, Researcher, 1995-1999.

Selected Publications

- Abdullah Bulbul, Tolga Capin, Guillaume Lavoué, Marius Preda, Assessing Visual Quality of 3-D Polygonal Models, IEEE Signal Processing Magazine, IEEE Press, **28(6)**, 80-90 (2011). DOI: 10.1109/MSP.2011.942466.

- Atanas Gotchev, Gozde Bozdagi Akar, Tolga Capin, Dominik Strohmeier, Atanas Boev, *Three-Dimensional Media for Mobile Devices*, Journal of Proceedings of the IEEE, IEEE Press, **99(4),** 708-741 (2011). DOI:10.1109/JPROC.2010.2103290.

- Cihan Halit, Tolga Çapın, *Multiscale Motion Saliency For Keyframe Extraction From Motion Capture Sequences,* Computer Animation and Virtual Worlds, Wiley, **22(1),** 3-14 (2011). DOI:10.1002/cav.380.

- Abdullah Bülbül, Zeynep Çipiloğlu, Tolga Çapın, *A Perceptual Approach for Stereoscopic Rendering Optimization*, Computers and Graphics Journal, Elsevier Press, **34 (145-157)** (2010). DOI:10.1016/j.cag.2009.11.004.

- Abdullah Bülbül, Zeynep Çipiloğlu, Tolga Çapın, *A Color-Based Face Tracking Algorithm for Enhancing Interaction with Mobile Devices*, The Visual Computer Journal, Springer, **26(5)**, 311-323 (2010). DOI:10.1007/s00371-010-0419-0.

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More Information

Asst. Prof. Tolga Çapın
http://www.cs.bilkent.edu.tr/~tcapin
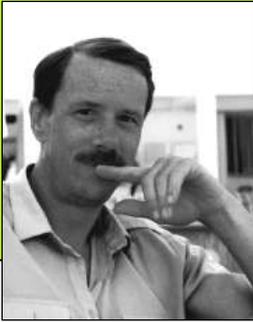
David Davenport

david@cs.bilkent.edu.tr
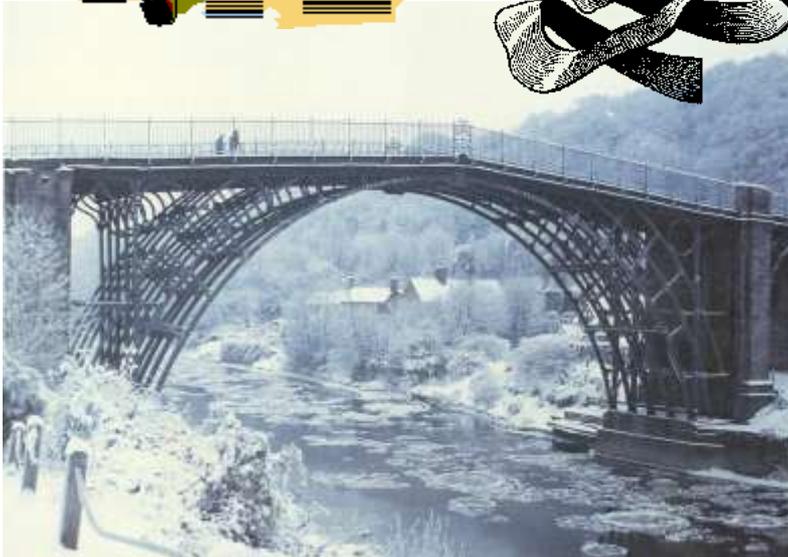
WANTED
ALIVE
Self-motivated, creative, committed

Graduate Students

Interested in…

- Unraveling mysteries of cognition
  (Center for Mind language & Culture)
- Information Quality – (ColSys group)
- Computer use in Education
- Ethical concerns raised by Internet

Contact: **David**   david@cs.bilkent.edu.tr

Tuğrul Dayar
(tugrul@cs.bilkent.edu.tr)

- **Performance modeling and analysis**
- **Scientific computing (especially numerical linear algebra for stochastic matrices)**
- **Bioinformatics**
- **Computer networks**

requires solid background:

1) in computer engineering

2) specifically in probability theory, linear algebra, numerical analysis, and high-level programming,

which one must either have or be willing to develop

Visit:

www.cs.bilkent.edu.tr/~tugrul/tugrul.html

for further information

41

Uğur Doğrusöz

On Research of **i-Vis**

Information Visualization Research Group

> For us, **research** is *practical solutions* to *real problems* using *strong theory*!

Topics: *Graph visualization, bioinformatics & graph algorithms*

Projects:

- **PATIKA** & **Visibio** [Pathway Modeling, Analysis & Visualization Tools]
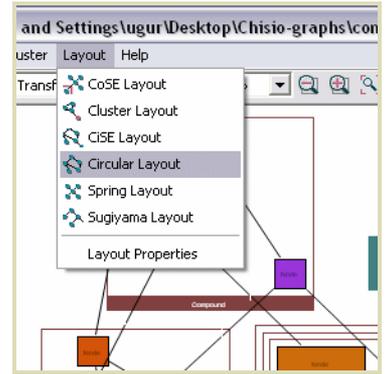
- **Chisio** [Graph Visualization Tool]

Our projects have been supported by TÜBİTAK and Tom Sawyer Software (CA, USA)

Social Network of Drug Traffickers
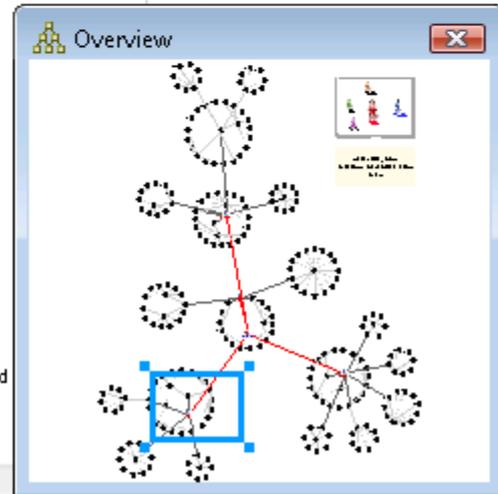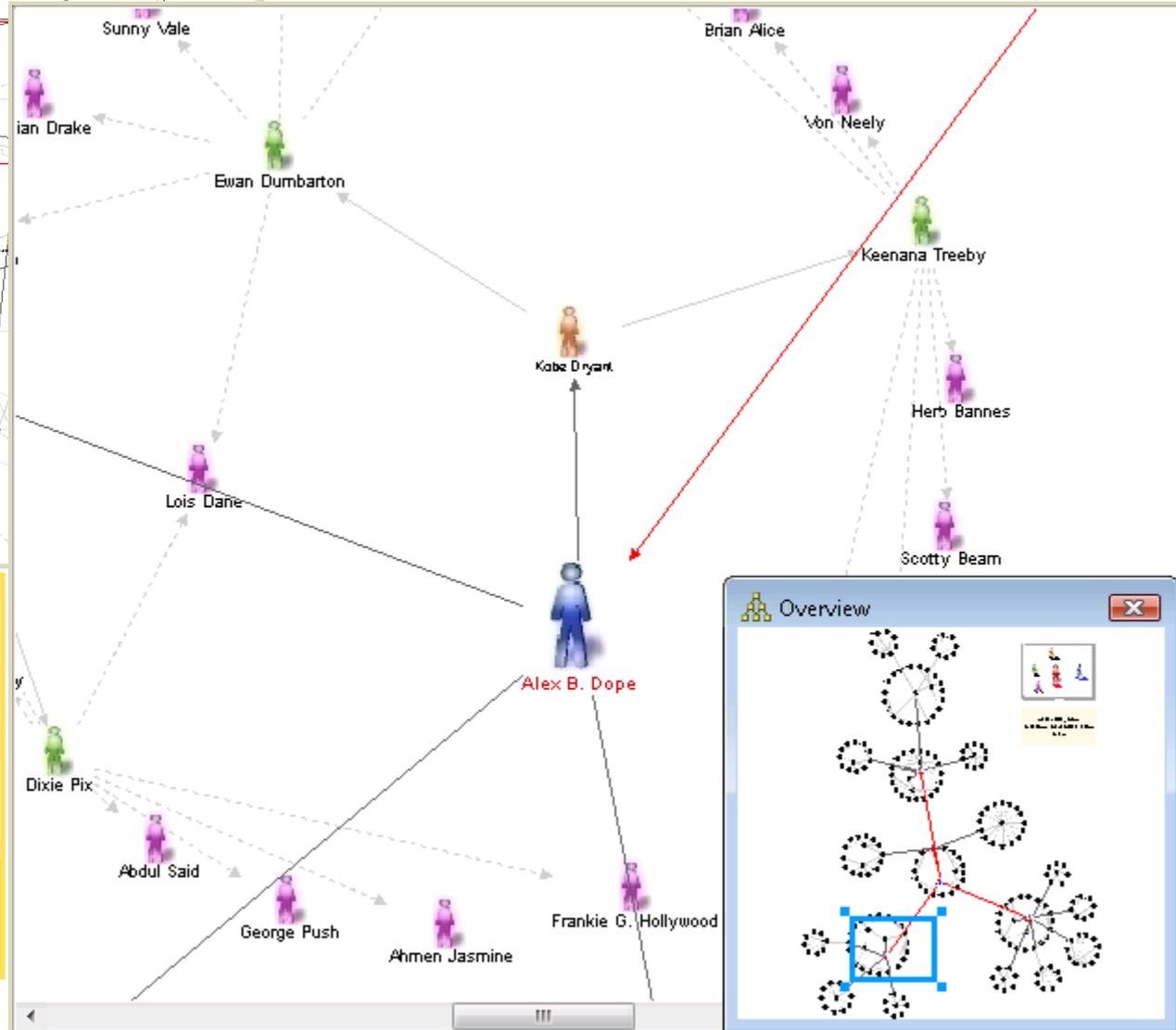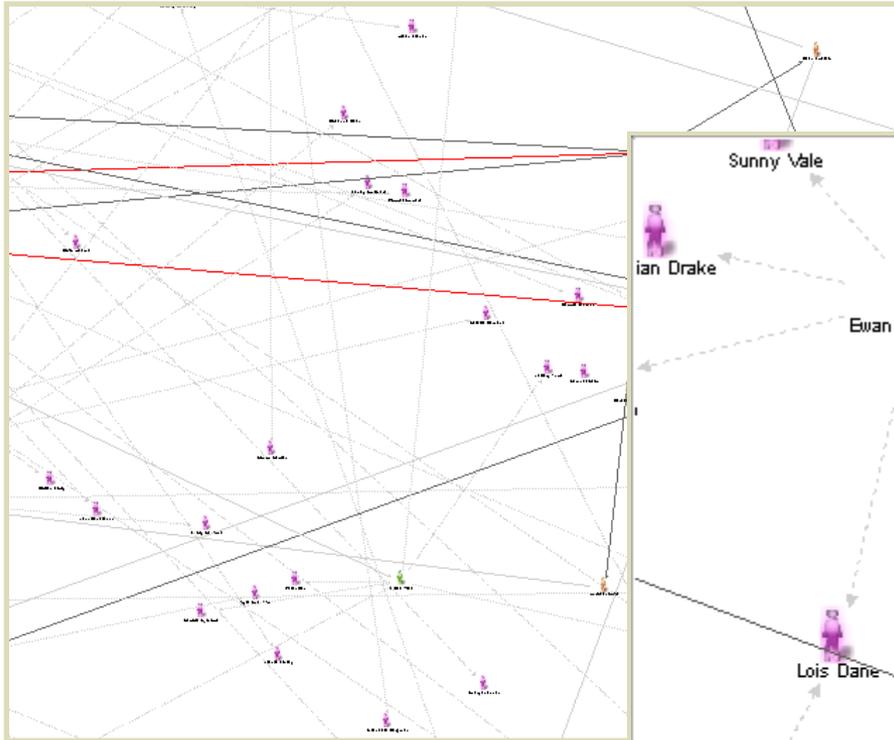
Chisio Drawing Tool
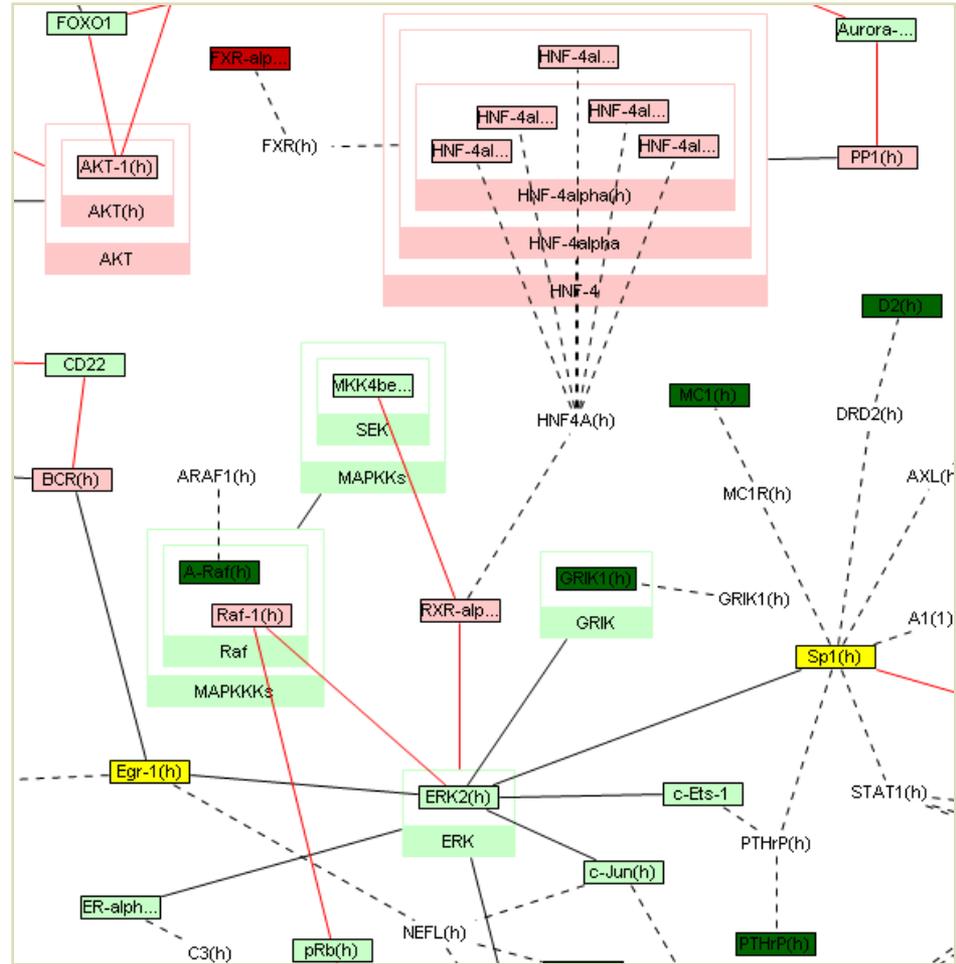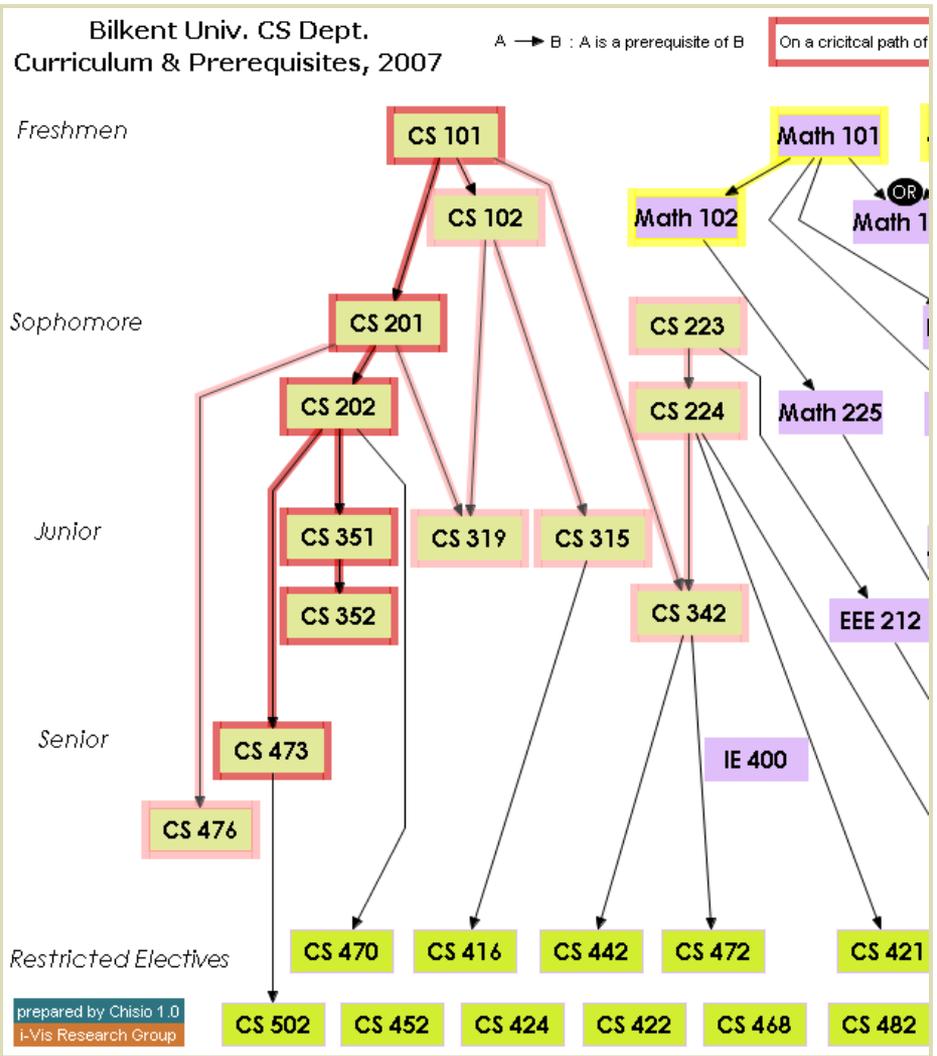
The PATIKA Project
www.patika.org

Sample PATIKA Tool: PATIKA*web*

Lost in the jungle of cellular processes…?

PATIKA*web* *can show you the PATHway*

Uğur Doğrusöz

i-Vis Research Group

www.cs.bilkent.edu.tr/~ugur

Interested in being part of this kind of research & development?

Then join us! Please **contact me** at ugur@cs.bilkent.edu.tr

Pınar Duygulu-Şahin

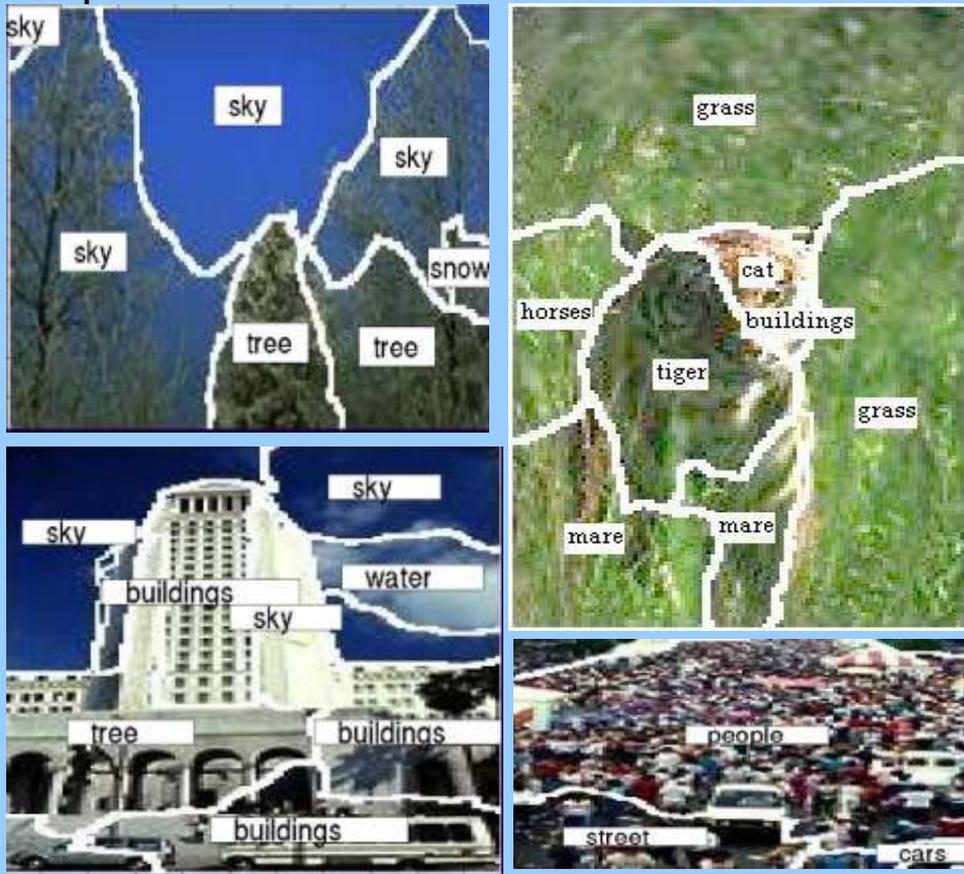duygulu@cs.bilkent.edu.tr
http://www.cs.bilkent.edu.tr/~duygulu

- What do you see in the picture?
- Do you want to build Image/Video Google?
- Do you want to organize your home photos?
- How many objects or faces can a computer recognize?
- Do you want your computer to read Ottoman letters
- Do you want to take care of your grandparents or kids while you are away from home?

Research Areas: Computer Vision, Pattern Recognition, Multimedia Data Mining

RETINA Vision and Learning Group
TÜBİTAK and EU funded projects

Object Recognition on large

sky
sky
sky
sky
snow
tree
tree

grass
cat
horses
buildings
tiger
grass
mare
mare

sky
sky
water
buildings
sky
tree
buildings
buildings

people
street
cars

Organizing Image Archives

Finding Images to illustrate text
Mobydick

Associating Names and Faces

George W. Bush

Bill Clinton

Video Segmentation

logos   News story

Headline
NEWS

weather   commercials   sports

Data Management and Mining
Hakan Ferhatosmanoglu

- We investigate data management and data mining methods for emerging applications:

  - Data streams (telecom data warehouses, financial markets)
  - Social Media (Twitter text and social network)
  - Bioinformatics (proteins, genes)

- We aim to build scalable systems for online exploration of text, image, time-series

- Funded by USA Dept of Energy, NSF, NASA, Pfizer, IBM

Data Management and Mining
Hakan Ferhatosmanoglu

- Looking for students with theoretical interest and systems building skills (basically math and programming..)

Please contact me for more information:

hakan@cs.bilkent.edu.tr

Buğra Gedik

○ We are conducting research in data-intensive distributed systems, looking at issues such as parallelization, load balancing, load shedding, placement optimization, fault-tolerance, etc.

○ Particular topics of interest include:

- o Distributed data stream processing systems

- o Big Data technologies, such as distributed key-value stores, map/reduce systems, bulk-synchronous parallel processing frameworks, etc.

- o Large-scale distributed graph management and mining

- o Peer-to-peer, mobile, and sensor data management

Data Stream Processing Systems

Stock market
- Impact of weather on securities prices
- Analyze market data at ultra-low latencies

Law Enforcement, Defense & Cyber Security
- Real-time multimodal surveillance
- Situational awareness
- Cyber security detection

Fraud prevention
- Detecting multi-party fraud
- Real time fraud prevention

Transportation
- Intelligent traffic management

e-Science
- Space weather prediction
- Detection of transient events
- Synchrotron atomic research

Manufacturing
- Process control for microchip fabrication

Health & Life Sciences
- Neonatal ICU monitoring
- Epidemic early warning system
- Remote healthcare monitoring

Telephony
- CDR processing
- Social analysis
- Churn prediction
- Geomapping

Other
- Smart Grid
- Text Analysis
- Who's Talking to Whom?
- ERP for Commodities
- FPGA Acceleration

Natural Systems
- Wildfire management
- Water management

Automatic Parallelization

pipeline

task

data
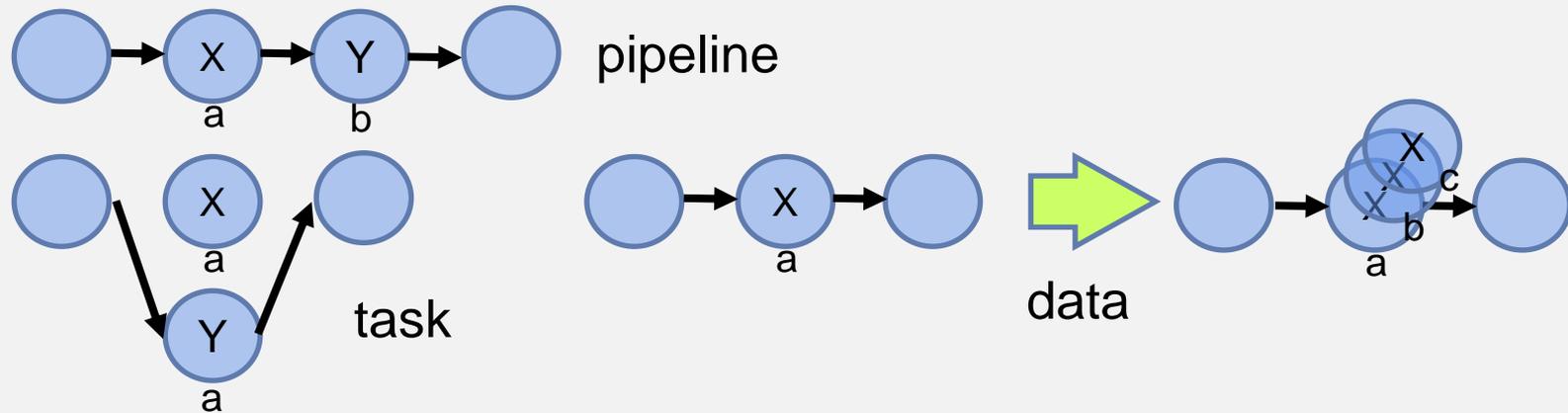
- Transparent parallelization: Locate parallel regions in streaming applications without user intervention

- Safe parallelization: Generate parallel alternatives that produce the exact same results as the sequential version

- Elastic parallelization: Dynamically adjust profitability decisions w.r.t. parallelization based on run-time dynamics

Data Intensive Distributed Systems
@ Bilkent University

Looking for students

We are seeking highly motivated and skilled students for graduate level research in data intensive distributed systems. Both Ph.D. and Masters level students are welcome. Students with strong interest in systems and implementation as well as a good understanding of fundamental theory are encouraged to apply.

Contact: www.bugragedik.com

Selected Publications

○ Buğra Gedik and Henrique Andrade. "A Model-Based Framework for Building Extensible, High Performance Stream Processing Middleware and Programming Language for IBM InfoSphere Streams", Software - Practice and Experience Journal, Wiley (SP&E), 2012.

○ Buğra Gedik, Kun-Lung Wu, Ling Liu, and Philip S. Yu. "Load Shedding in Mobile Systems with MobiQual", Transactions on Knowledge and Data Engineering, IEEE (TKDE), 2010.

○ Buğra Gedik, Rajesh R. Bordawekar, and Philip S. Yu. "CellJoin: A Parallel Stream Join Operator for the Cell Processor", Very Large Data Bases Journal - Special Issue on Best Papers from VLDB 2007, (VLDBJ), 2009.

○ Buğra Gedik, Ling Liu, and Philip S. Yu. "Asap: An Adaptive Sampling Approach to Data Collection in Sensor Networks", Transactions on Parallel and Distributed Systems, IEEE (TPDS), 2007.

○ Buğra Gedik and Ling Liu. "MobiEyes: A Distributed Location Monitoring Service Using Moving Location Queries", Transactions on Mobile Computing, IEEE (TMC), 2006.

○ Buğra Gedik and Ling Liu. "A Scalable Peer-to-Peer Architecture for Distributed Information Monitoring Applications", Transactions on Computers, IEEE (TC), 2005.

Computer Graphics

Faculty: Uğur Güdükbay and Bülent Özgüç

Human modeling and Animation

- **Motion control techniques**
- **Realistic rendering for multi-layered human models**
- **Facial modeling and animation**
- **Hair simulation**
- **Motion capture techniques**
- **Crowd simulation**

Physically-based Modeling

- **Interaction of deformable objects with environment**
- **Fluid simulation**
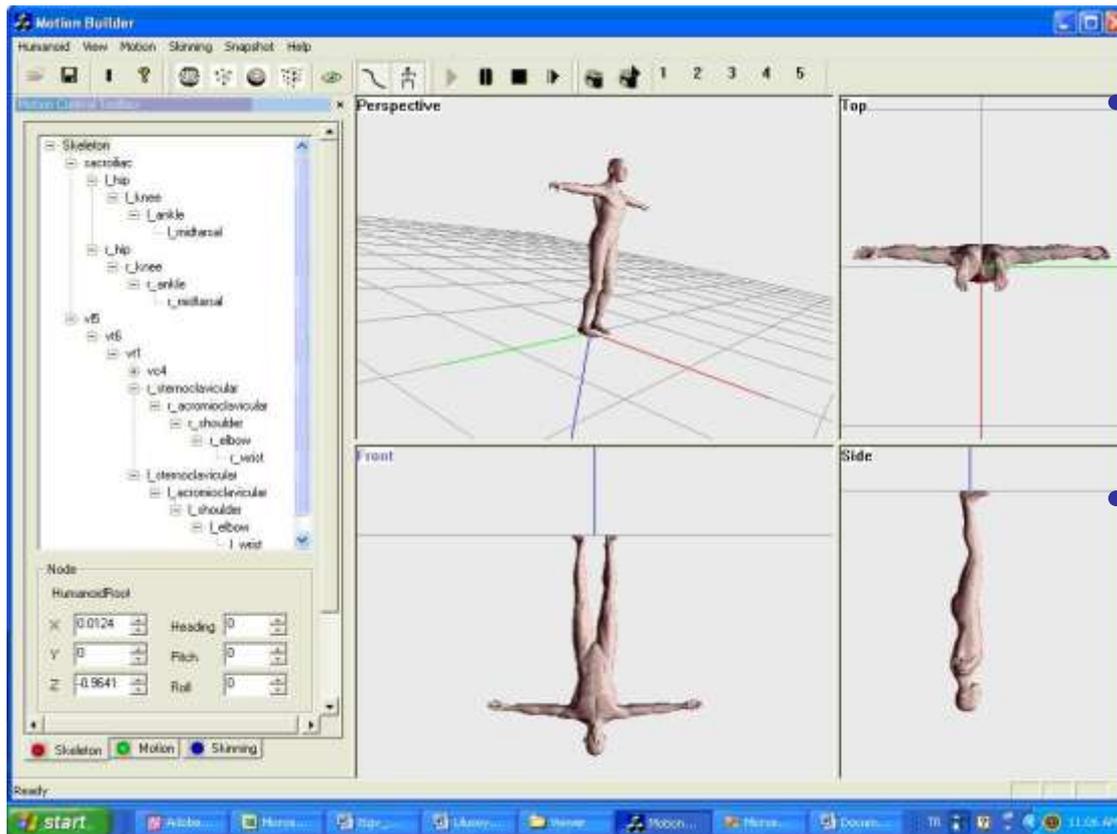- **Interaction of fluids with rigid and deformable objects**
- **GPU-based approaches**

Dynamic 3D Scene Represent.

- **Mesh simplification**
- **View-dependent visualization**
- **Terrain and urban visualization**
- **Stereoscopic visualization**

Natural Phenomena

- **Burning Solids**
- **Furry object animation**
- **Animation of viscoelastic fluids**

Human Modeling and Animation

- **Motion Control Techniques**
  - **Dynamic**
  - **Kinematics**
- **Realistic Rendering of Human Models**
  - **Multi-layered**
  - **Muscle-based**
  - **Respiratory (upper body) behaviors**

57
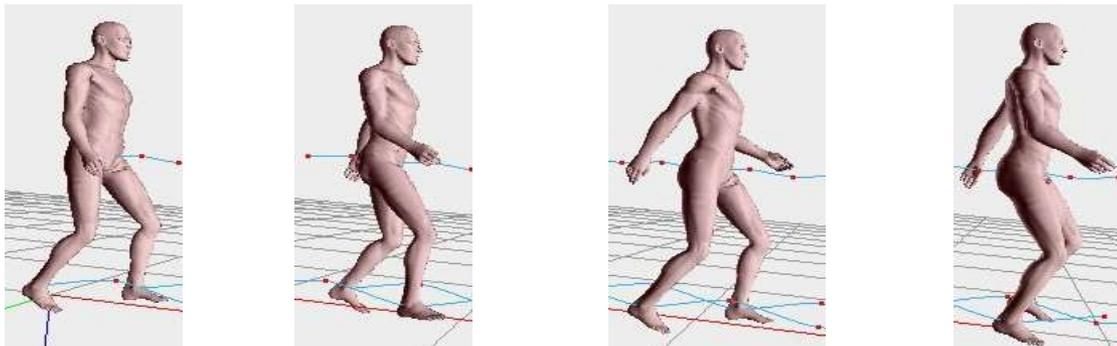
Facial Modeling and Animation
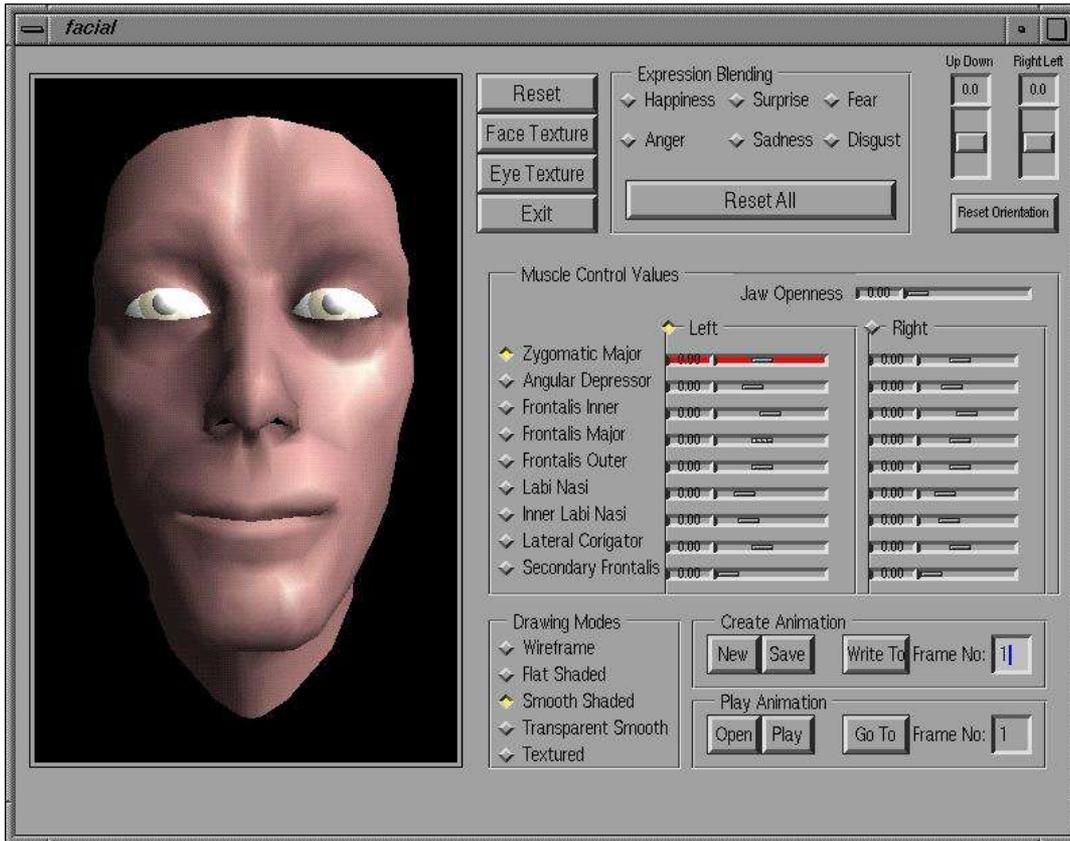
- **Muscle Based Face Models**

- **Facial Expression Synthesis**

- **Speech Animation**

- **Personalized Face Models**

- **MPEG-4 Face Animation**

Human Hair Simulation

- **Physically-based hair modeling**
- **Interaction of hair strips with**
  - **each other**
  - **external forces**
- **Real-time behavior**

Cloth Simulation

- **Garment Design**
  - **Woven Cloth**
  - **Knitted Fabrics**
- **Animation of Dressed Virtual Humans**
- **Physically-based simulation of cloth behavior**
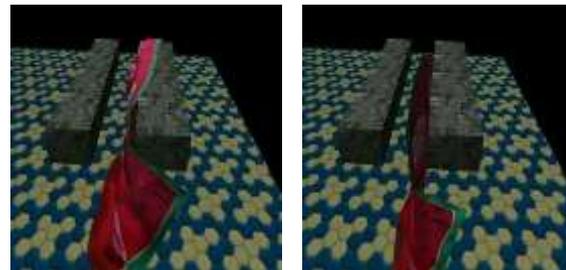
Burning objects   Fur Simulation

- **simulating burning wood or coal**
- **emphasis is on burning source rather than flames**

- **generation of fur**
- **animation of fur under external forces**

Liquid Animation

Liquid particles falling in a glass
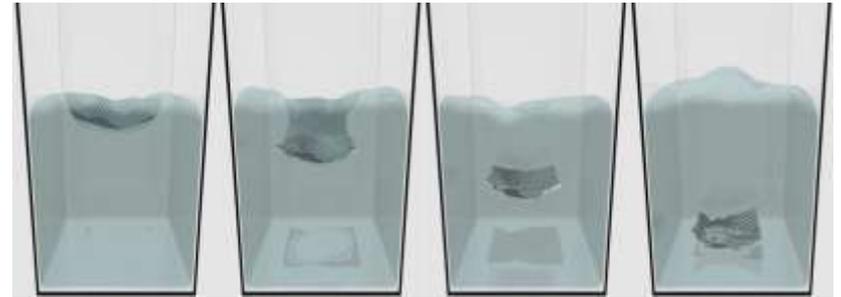
Heavy cloth sinks into water
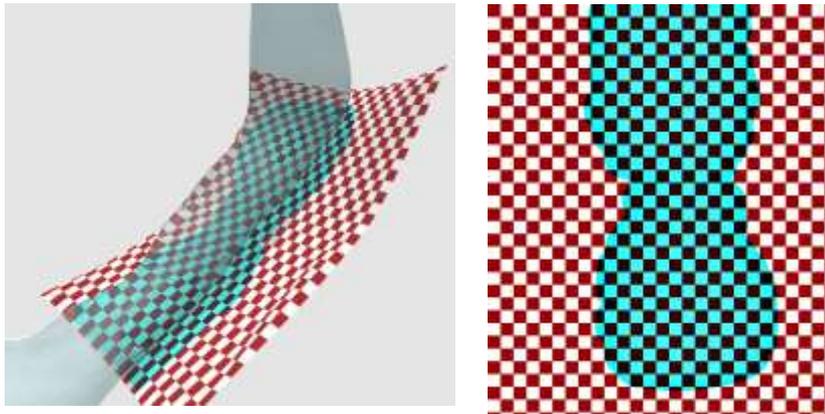
Liquid Stain On Cloth
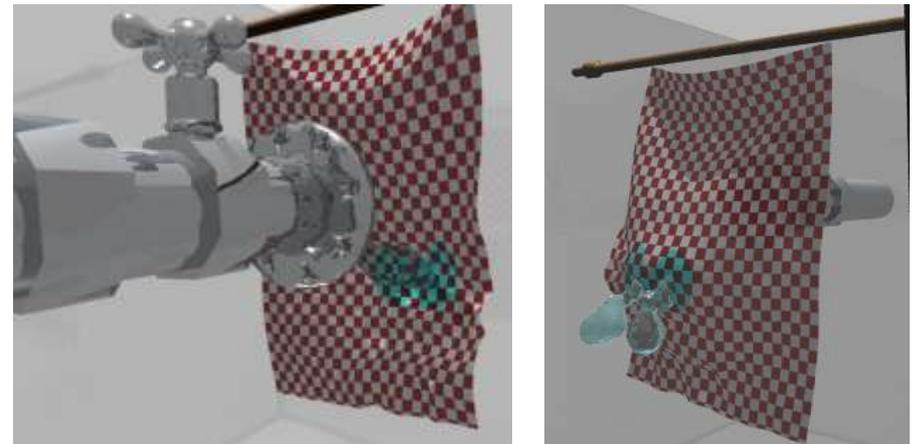
Liquid flowing through cloth

Viscoelastic Fluids
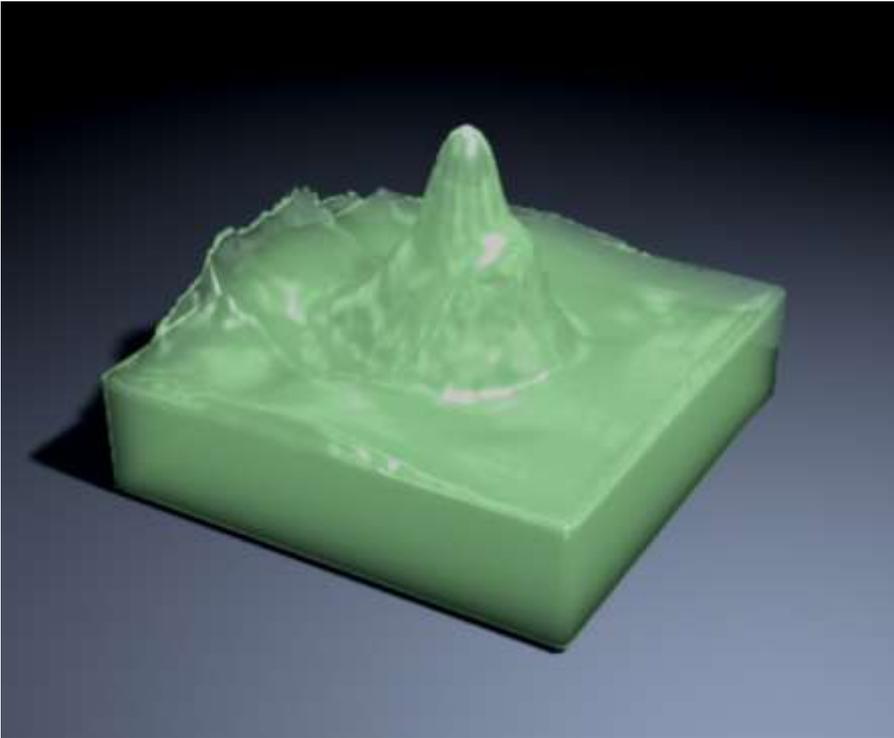
- **Viscoelastic fluids are paste or jelly-like substances**

- **Generation of viscoelastic fluids**

- **Simulation of the flow behavior of them**

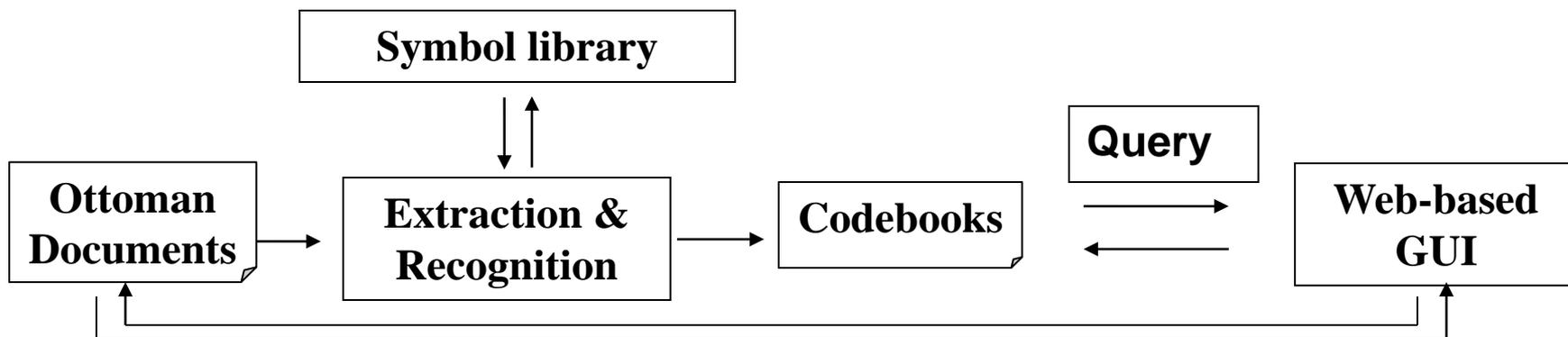- **Interaction of these fluids with the environment**

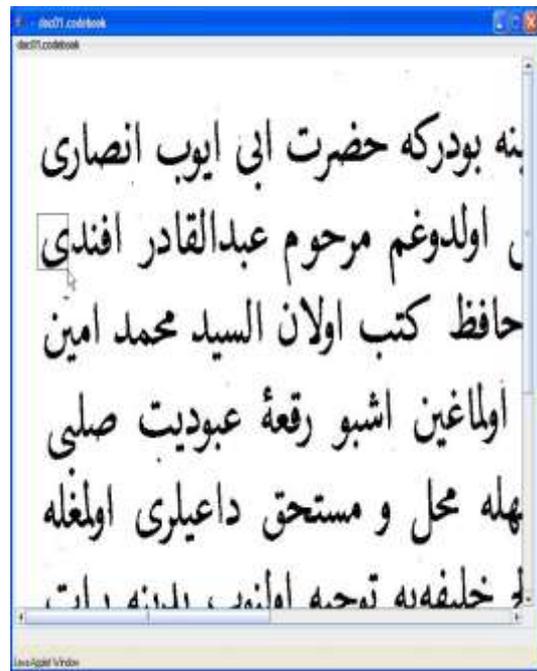# Terrain and Urban Visualization
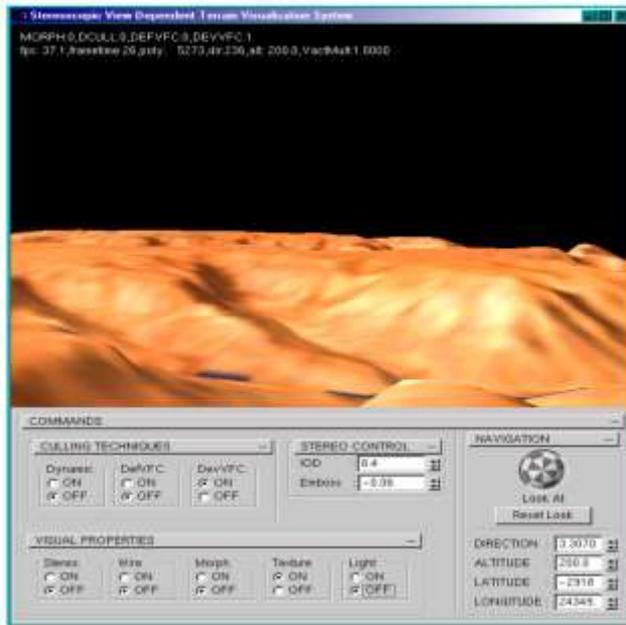
- **Mesh simplification techniques**
- **View-dependent visualization techniques**
- **Terrain and urban visualization**
- **Stereoscopic visualization**
- **Crowd simulation in urban environments**
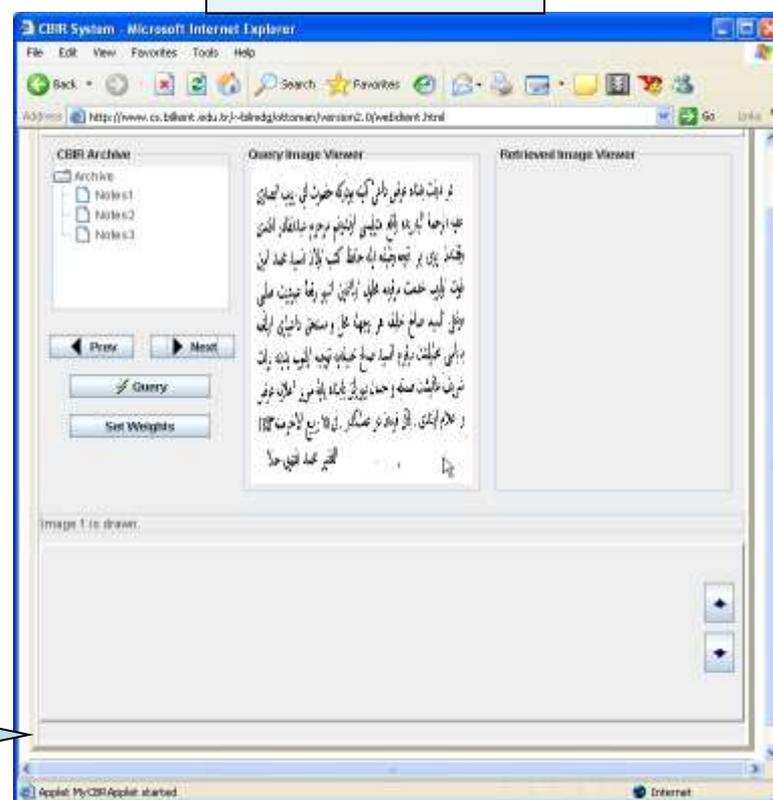
Ottoman Archive Content-Based Retrieval System

Computational Biology Research Group

Çiğdem Gündüz Demir

Main research interests:

- Medical image analysis for **automatic cancer diagnosis, grading, and prognosis**

- Machine learning for **intelligent medical systems**
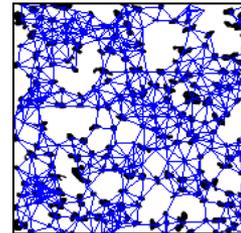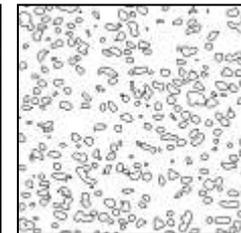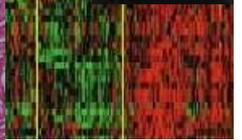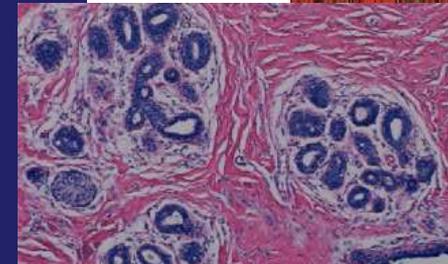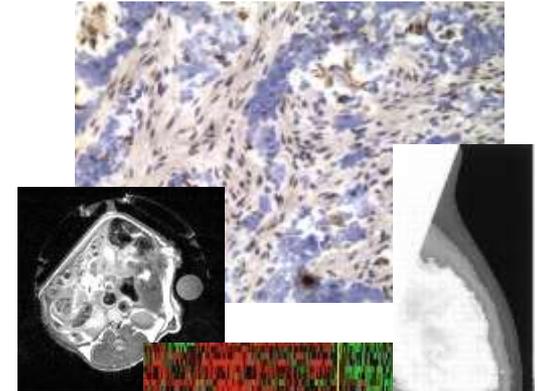
Computational Biology Research Group

Çiğdem Gündüz Demir
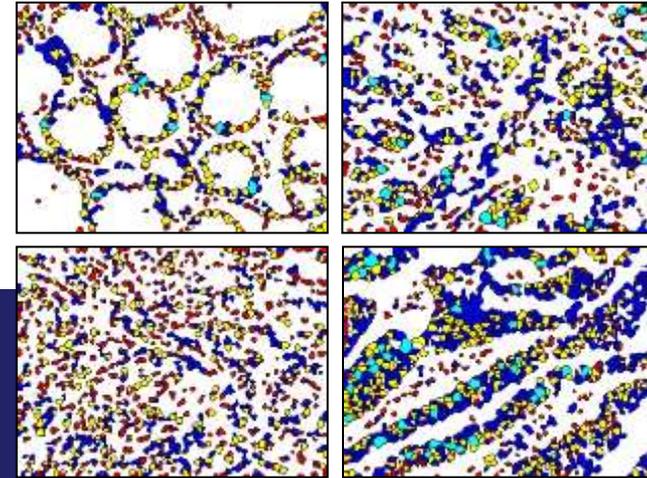
Current projects:

- Diagnosis and grading of colon cancer
  - Construction of new biocomputational methods
  - Colon cancer diagnosis
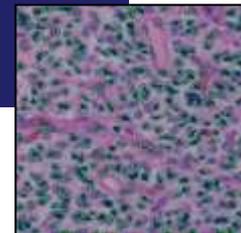 - Colon cancer grading
  - Tissue image segmentation
  - Colon gland segmentation

- Designing medical diagnostic systems
  - Cost-sensitive classification
  - Qualitative decision theory
  - Dynamic model selection and combination
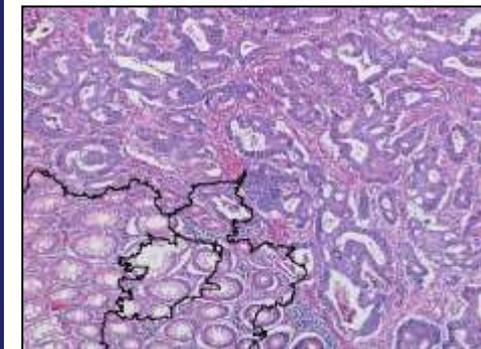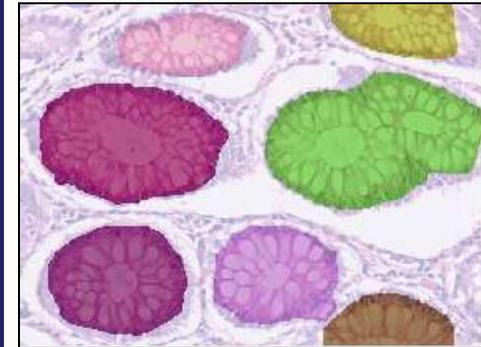
Machine Learning and Data Mining

Current research topics include

Learning to

- ➢ rank instances
- ➢ model risk factors
- ➢ estimate risks
- ➢ suggest to increase chances for a given class
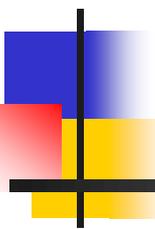
Networking and Systems Research Group
Department of Computer Engineering

Faculty Member:

İbrahim Körpeoğlu
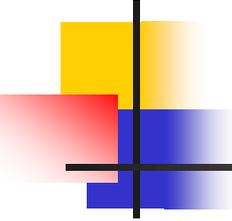
Goal of the Group

- To do research in the area of Computer Networking, Wireless Networking and Distributed Systems.

Sponsored Projects and Sponsors

- Group is involved in projects sponsored by:
  - TUBITAK
    - 104E028: Project on ad hoc / sensor networks
    - 103E014: Project on Bluetooth (completed)

  - Intel Corporation
    - WNCE: Project on wireless education

  - European Union FP7 Program
    - Newcom++: Project on wireless communication
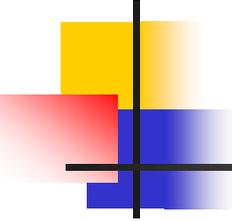
Current Research Topics

- Wireless sensor networks
- Wireless mesh networks
- P2P networks

Wireless Sensor Networks

- Wireless sensor networks are used to collected information from a region; to monitor a region; to control a region.

- Small sensor devices deployed
- Wireless communication is used

- Routing,
  data dissemination,
  medium access,
  application problems
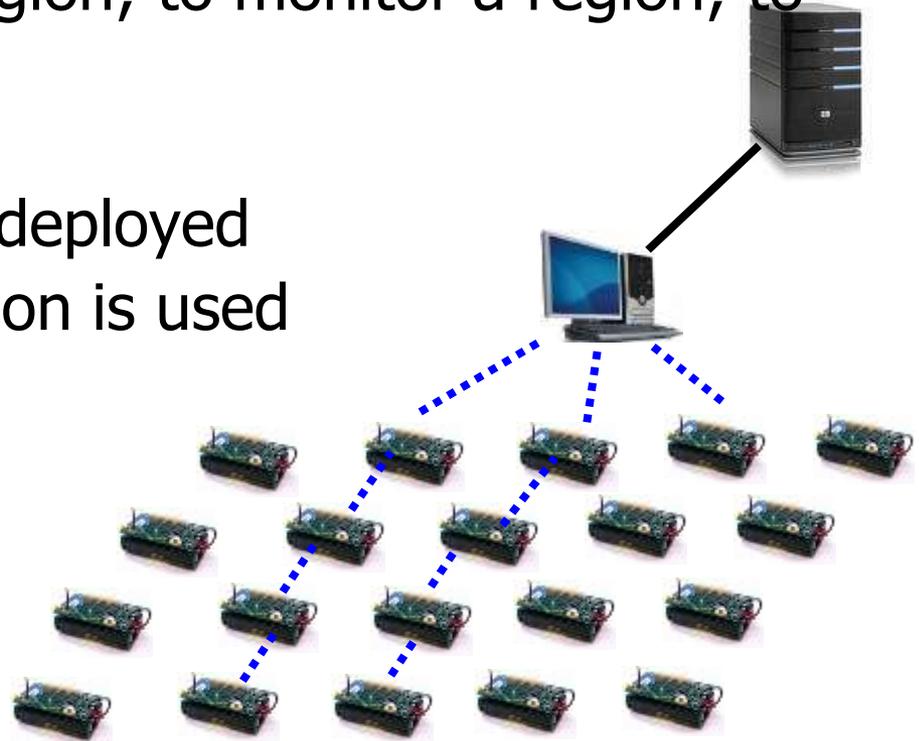
Wireless Mesh Networks

- Collection of wireless access points and routers interconnected together with wireless links and providing backbone services

- This is a new use of wireless routers; Previously: just for wireless access

- Routing, channel assignment, deployment, applications, performance problems

Wireless access

Wireless Backbone

Wireless access
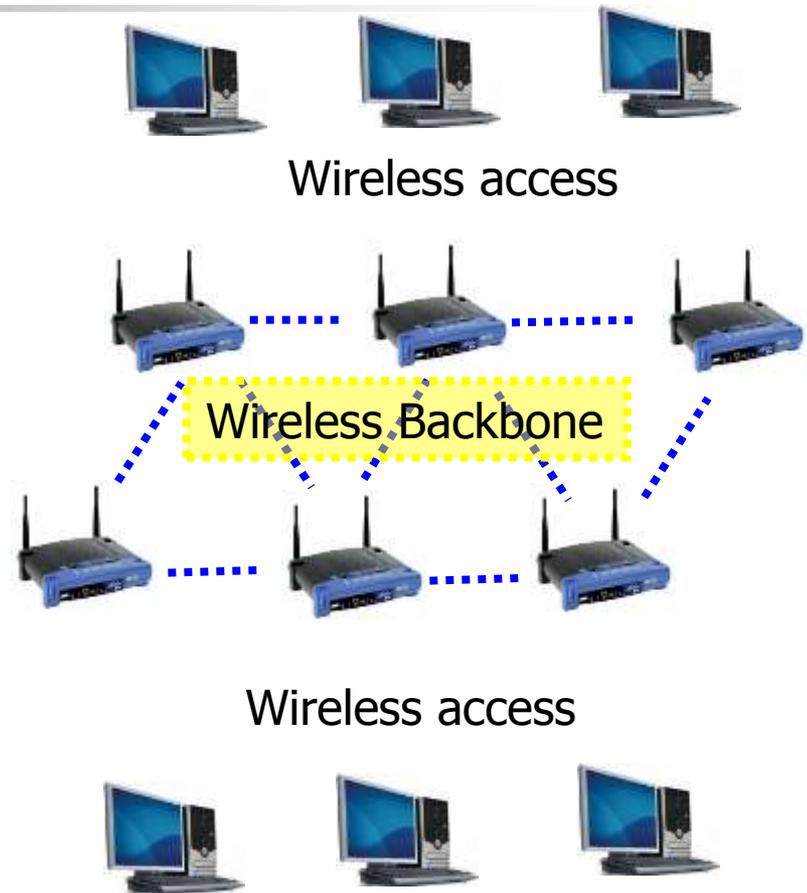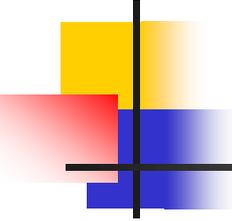
P2P Networking

- P2P Free Riding Solutions
- P2P Routing/Queries
- Efficient P2P query routing techniques
- Mobile P2P applications and supporting protocols

- Joint work with Prof. Dr. Ozgur Ulusoy
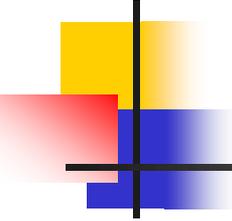
More information

- **From the website of the faculty member**
  - http://www.cs.bilkent.edu.tr/~korpe/
- **From the group's website**
  - http://www.cs.bilkent.edu.tr/~korpe/lab/network-lab.html

Dr. Özcan Öztürk

Office: EA 407B Phone: 290-3444
Email: ozturk@cs.bilkent.edu.tr
URL: http://www.cs.bilkent.edu.tr/~ozturk

- ◉ Multicore Architectures
  - Network-On-Chip (NoC) Architectures
    - ○ Intel 80 core Teraflop Processor
  - Heterogeneous Chip Multiprocessors
    - ○ IBM/Toshiba/Sony Cell Processor
- ◉ Optimizations
  - Performance
  - Energy
  - Reliability
  - Thermal
- ◉ Methods
  - Parallelization
  - Data
  - Thread
  - Memory Organization
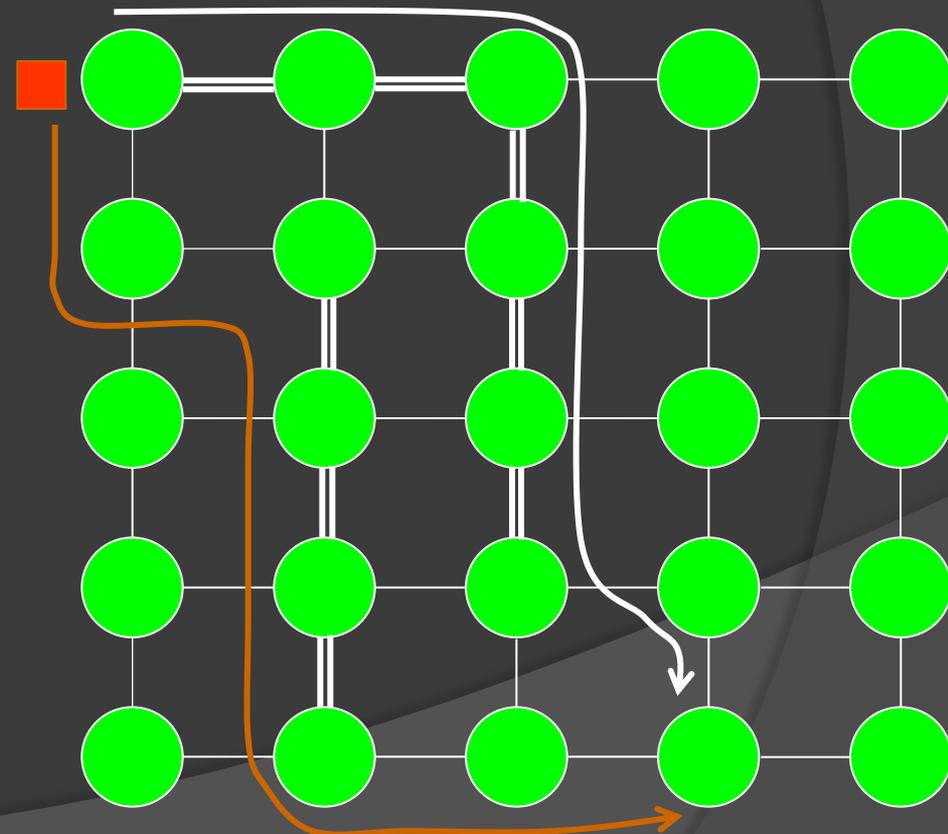
Dr. Özcan Öztürk

Office: EA 407B Phone: 290-3444
Email: ozturk@cs.bilkent.edu.tr
URL: http://www.cs.bilkent.edu.tr/~ozturk

◉ Embedded Systems
- Most of the processors used are in embedded domain
  ○ Cell phones / PDAs
  ○ Automotive industry
  ○ MP3 players
  ○ Network routers
  ○ Storage devices
◉ Common Characteristics
- Battery operated
- Area limited
- Memory limited
- Real-time
◉ Software Optimizations for Embedded Systems
- Low-power Architecture Design
- Memory Distribution and Hierarchy
- Banked Memories
- Application specific optimizations
- Code compression
- Data compression

IN

P P P P P P

PM PM PM SM

(Highest level)

SM

SM

SM

(lowest level)

On-chip memory
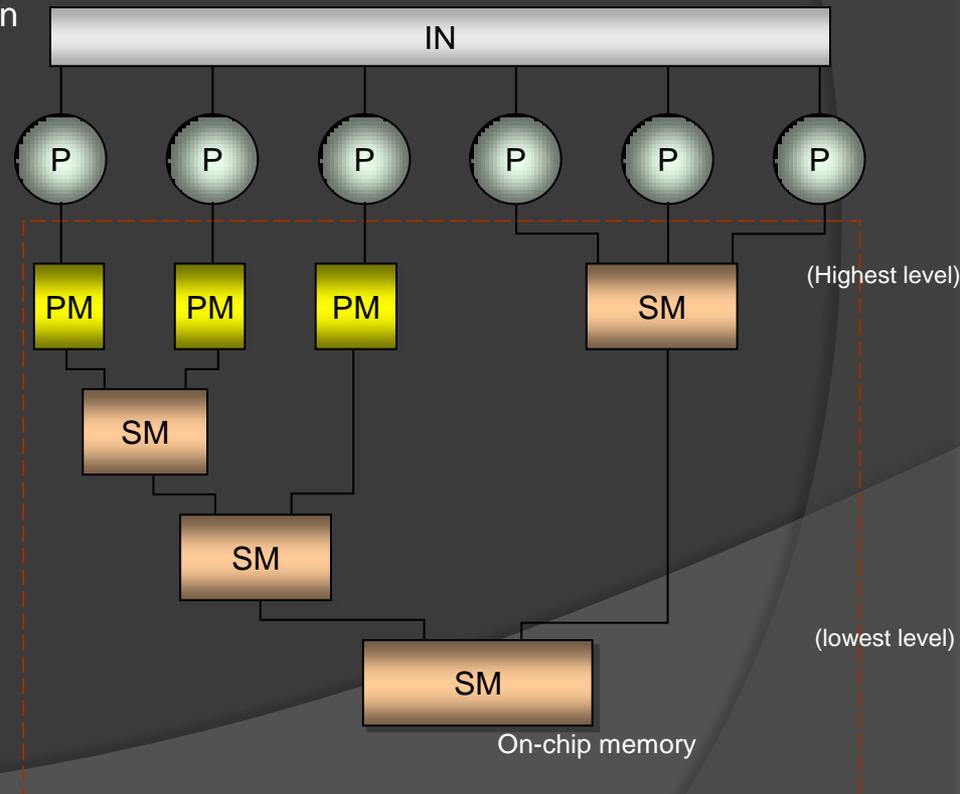
Information Security Group
Dr. Ali Aydın Selçuk

Cryptography Mathematical and algorithmic fundamentals
- Cryptanalysis of block ciphers
- Mathematical protocols for secret sharing

Network security Protocols to secure information networks
- More functional authentication protocols for GSM
- Trust establishment protocols for P2P networks

Systems security Securing computer systems
- Detection of spyware /ghostware on PCs
- Prevention of buffer overflow attacks

More information: http://www.cs.bilkent.edu.tr/~selcuk

Bedir Tekinerdoğan

BilSen
Bilkent Software Engineering
Research and Education

Mission Statement

- *We are dedicated to continued growth in the field of software engineering and aim to provide excellence in research, teaching and service relative to the university in particular and the community in general.*
- *We are committed to responsible and innovative way of working and collaboration with academic and industrial partners, both in Turkey and abroad.*
- *We aim to achieve our goals through publishing high quality papers, actively participating in the software engineering community, writing industrially relevant project proposals, and constant collaboration with our colleagues and students who understand the importance and value of software engineering.*

Vision

- *We believe that software engineering is one of the most important disciplines in computer science with the largest impact on the community.*
- *We envision that this influence on the society will remain for the future and will even get stronger for the coming decades.*
- *In particular, for Turkey with a highly developing potential, we think that software engineering should be put on the agenda for a broader interest and participation.*
- *Based on our in-depth experiences in different domains of software engineering we think that we can substantially contribute to the developments in state-of-the-art and state-of-the-practice of software engineering.*

http://www.cs.bilkent.edu.tr/Bilsen

Software Everywhere...

The Discipline that is Shaping our World....

Software Engineering

- an Engineering discipline
- that builds on Computer Science...
- and in particular Software Engineering Science

Computer Science

Software Engineering Science
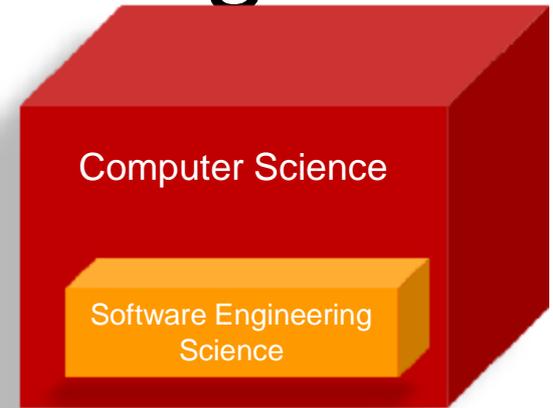
Engineering - Creating cost-effective solutions to practical problems by applying scientific knowledge building things in the service of mankind....

(M. Shaw and D. Garlan. Software Architecture: Perspectives on an Emerging Discipline, Prentice Hall, 1996)

Engineering

Electrical Engineering	Chemical Engineering	Civil Engineering	Mechanical Engineering	Software Engineering
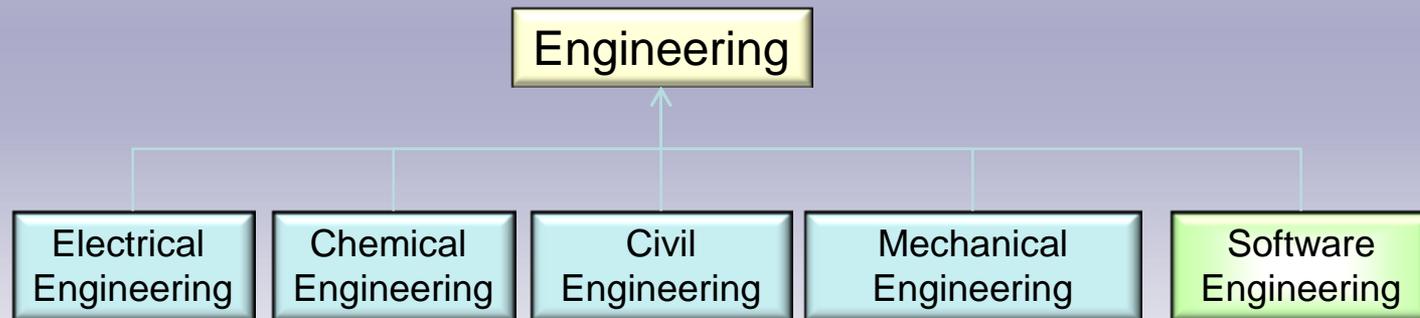
Research Topics

Software is *Hard*...

How to cope with inherent complexity...?

- **Research Topics**
- Software Architecture Design
- Software Product Line Engineering
- Aspect-Oriented Software Development
- Model-Driven Software Development
- Software Testing
- Software Requirements Engineering
- Quality-Driven Software Development
- Experimental Software Engineering
- ...

BilSen
Bilkent Software Engineering
Research and Education

Faculty

Dr. Bedir Tekinerdogan (Contact)
Research Topics: Software Architecture Design, Software Product Line Engineering, Model-Driven Software Development, Aspect-Oriented Software Development

Dr. Cengiz Çelik
Research Topics: Object-oriented software development, enterprise application development

Dr. David Davenport
Research Topics: Object-oriented software development, software development in AI, Collaborative Systems

Dr. Markus Schaal
Research Topics: Collaborative System development, Object-oriented software development, Agent-based software development

PhD Candidates

Ersin Er
Research Topic: Software Evolution, Model-Driven Software Development, Aspect-Oriented Software Development
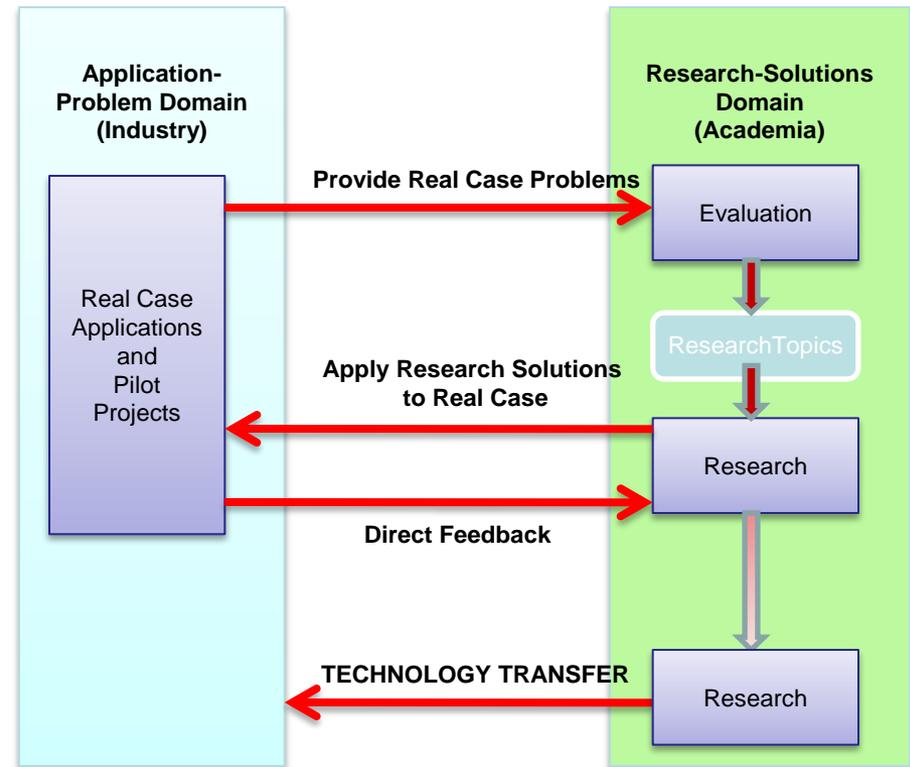
M. Ugur Aksu
Research Topic: Software Testing Automation, Software Architecture based Testing, Real Time System Design, Software Project Management

Our Strategy - Industry as Laboratory

BilSen
Bilkent Software Engineering
Research and Education

- **Problem is acquired from the real practitioners** in industry, (e.g industrial partners in a research project).
  - Stronger connection at start
  - solve problems that really do matter to practitioners
- Constant interaction by practitioners and researchers
- Early evaluation and usage by industry
- Optimal reduction of Technology Transfer Gap
- Increasing quality publications

Application-Problem Domain (Industry)

Real Case Applications and Pilot Projects

Research-Solutions Domain (Academia)

Evaluation

ResearchTopics

Research

Research

Provide Real Case Problems

Apply Research Solutions to Real Case

Direct Feedback

TECHNOLOGY TRANSFER

Database Research
Özgür Ulusoy
http://www.cs.bilkent.edu.tr/~oulusoy/

- **Web Databases and Search Engines**

- **Multimedia Databases**

- **Mobile and Peer-to-Peer Systems**

Web Databases and Search Engines

○ Social Web search and personalization

○ Temporal analysis of web search results

○ Efficiency and scalability issues for Web Search Engines (caching, index pruning)

○ Web information extraction

○ Modeling and querying of Web resources

○ XML querying & searching

○ ***http://www.cs.bilkent.edu.tr/~bilweb***
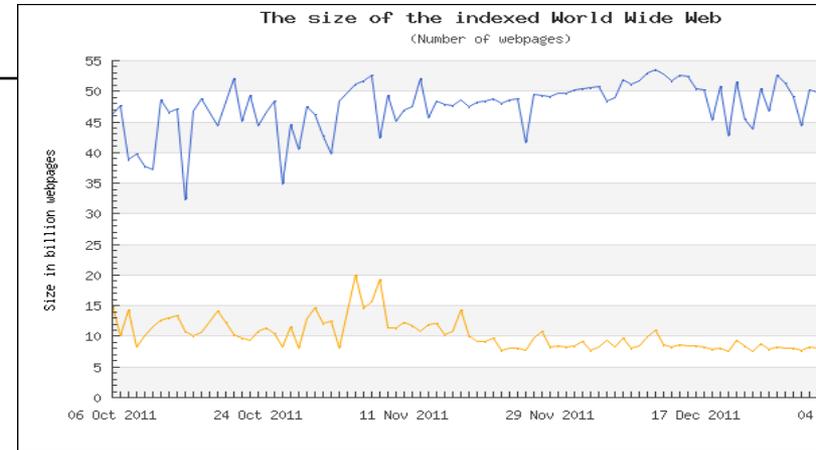
Search Engines are the key to access Web Data

2000 | First **billion-URL** index
The world's largest!
≈5000 PCs in clusters!

2008 | Google counts **1 trillion** unique URLs

1995 | S. Brin meets L. Page

The size of the indexed World Wide Web
(Number of webpages)

| 1995 | | 2012 |

1998 | Birth of Google

2004 | Index grows to **4.2 billion** pages

2009 | TBs or PBs of data/index
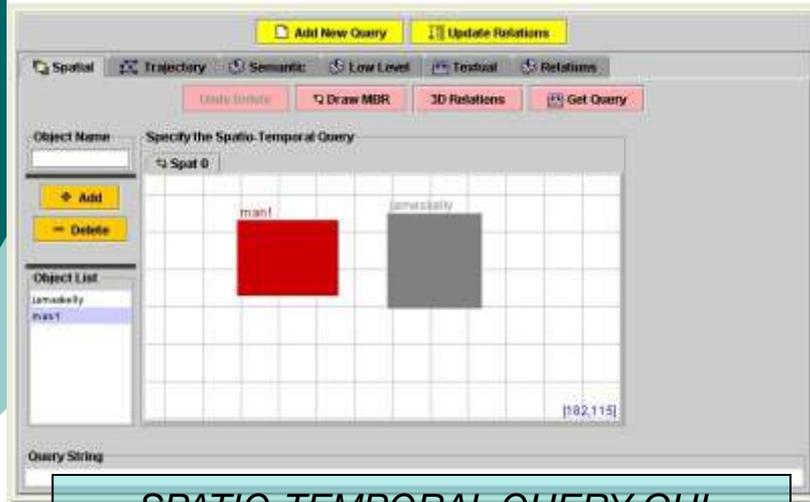Tens of thousands of PCs
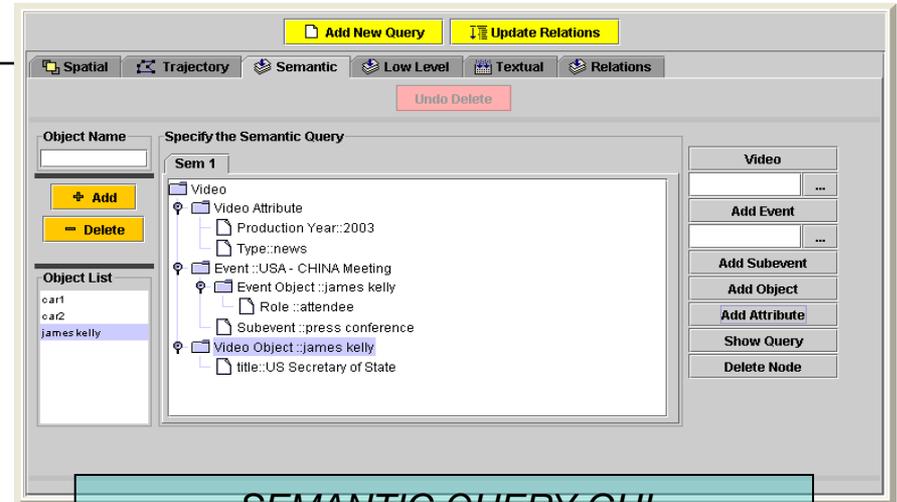
**Efficient and scalable strategies
are of vital importance !**

Multimedia Databases

- **BilVideo: A Video Database Management System**

- **Ottoman Archive Content-Based Retrieval System**

- ***http://www.cs.bilkent.edu.tr/~bilmdg***

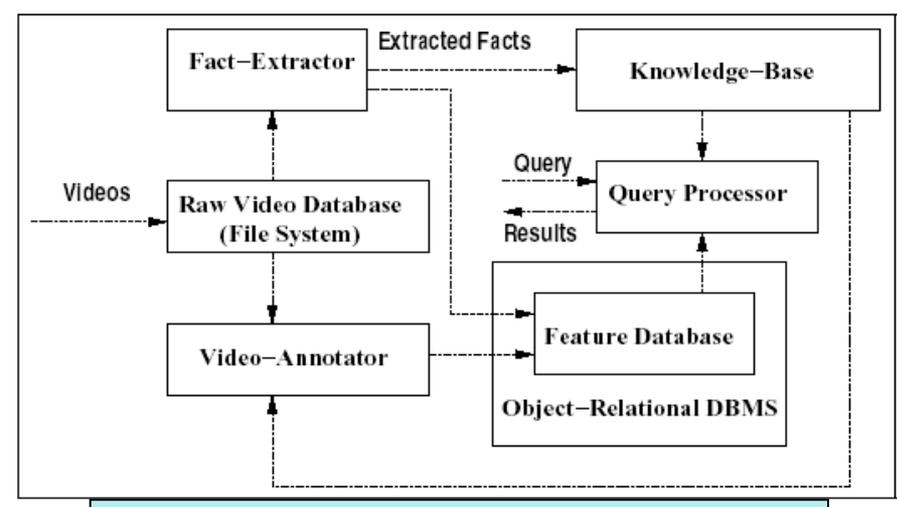# BilVideo: Integrated video DBMS supporting low-level, spatio-temporal, motion and semantic querying of videos
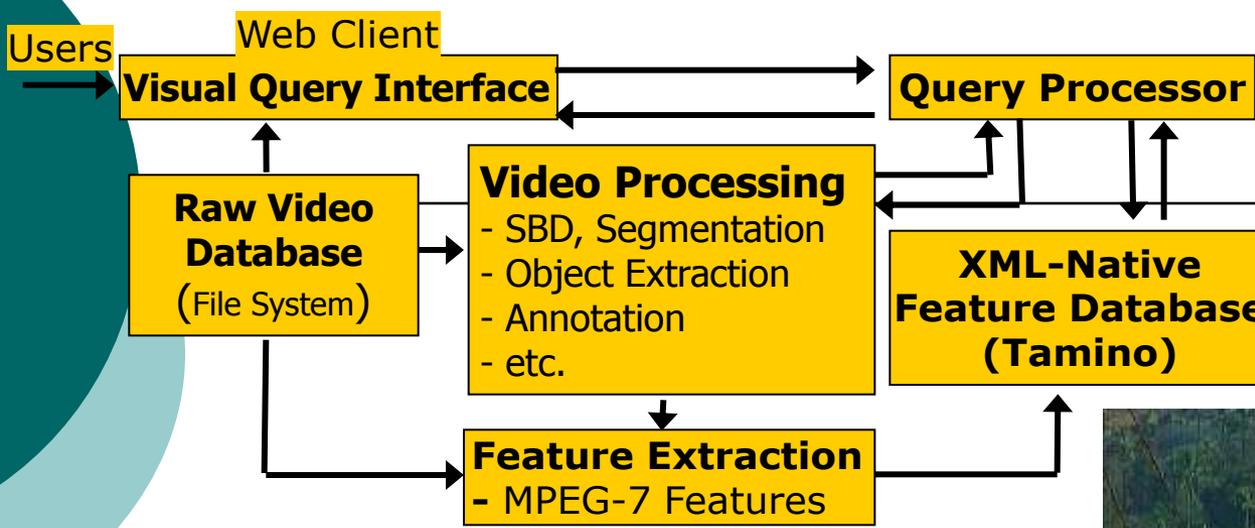

SPATIO-TEMPORAL QUERY GUI

SEMANTIC QUERY GUI

TRAJECTORY QUERY GUI

SYSTEM ARCHITECTURE

BilVideo v2.0: MPEG-7 Compliant Video DBMS

Users

Web Client
Visual Query Interface

Query Processor

Raw Video Database
(File System)

Video Processing
- SBD, Segmentation
- Object Extraction
- Annotation
- etc.

XML-Native Feature Database (Tamino)

Feature Extraction
- MPEG-7 Features

Automatic processing:
segmentation, tracking, feature extraction, annotation, indexing
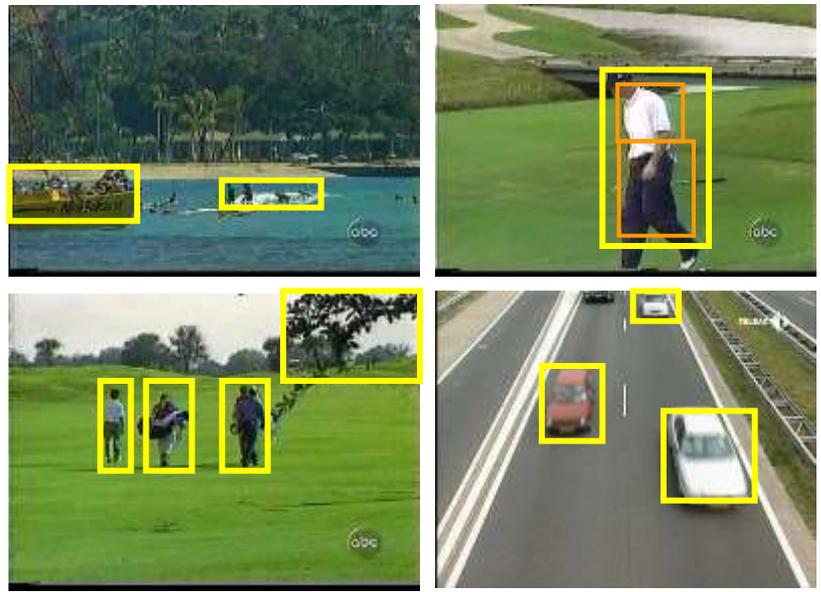
Powerful querying capability for video data
- keyword and content-based queries
- spatio-temporal object queries

segmentation

putin

bush

dog

Example query formulation

Salient video object extraction

keywords: trees, greenery, sky – bush, putin, dog

Mobile and P2P Systems

○ Moving Object Processing
(location indexing, location-dependent query processing)

○ Mobile Data Management
(data broadcasting, transaction processing, hoarding)

○ Peer-to-peer systems
(routing, free riding)

○ ***http://www.cs.bilkent.edu.tr/~p2p***