Automated Endoscopic Capsule Massive Analysis Using a Grid Computing Environment

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Outline

- Grid computing
- Endoscopic Capsule
- CV method for EC video processing
- EC massive analysis using Grid computing
- Conclusions

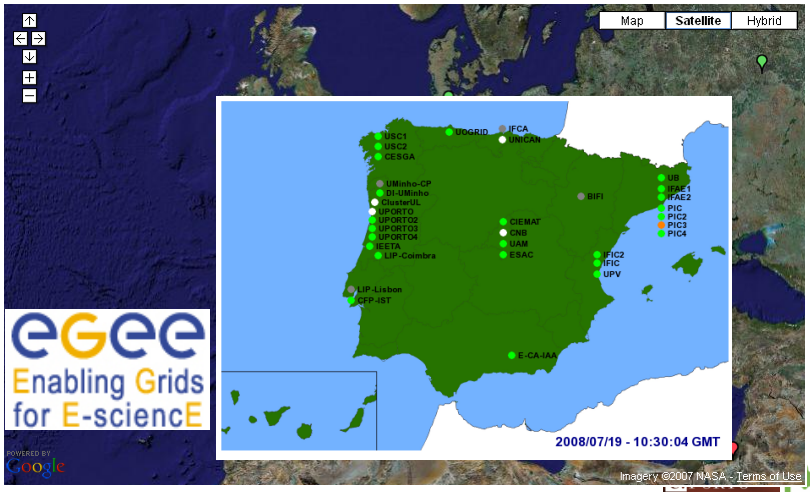
What is Grid/Cloud Computing ?

- Electrical Grid
  - When I want a toast all I have to do is plug it to electricity and turn my toaster on.
  - Principle: What I pay I get.
- Computional Grid/Cloud
  - When I need CPU and/or storage power all I have to do is “plug” to the network.
  - Principle: What I give to Grid, I can get in a concentrated way…

Enabling Grids E-SciencE (EGEE) project

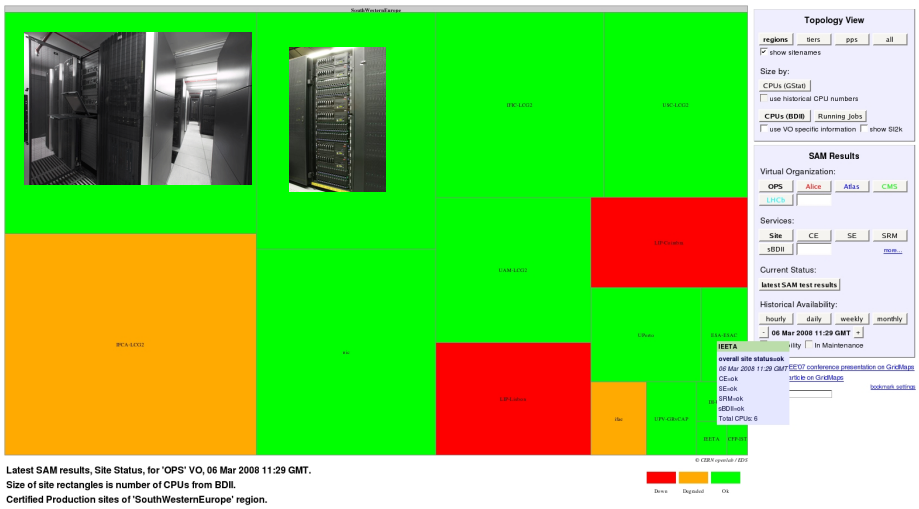
- Large Hadron Collider (LHC) is starting to produce 15 Petabytes / year (27km, 50-100m underground, CERN)
- Start April 2006 (EGEE-III)
- 90 institutions of 32 countries, led by CERN
- 100 000 CPU, 15 Petabytes
- Organized in “Virtual Organizations” and federations
  - (W)LCG – quantum physics
  - Biomed – Biomedical computing
  - Earth – Earth sciences
  - Aero – Aeronautics simulation
  - Ops and dteam (operations)

EGEE project - www.eu-egee.org



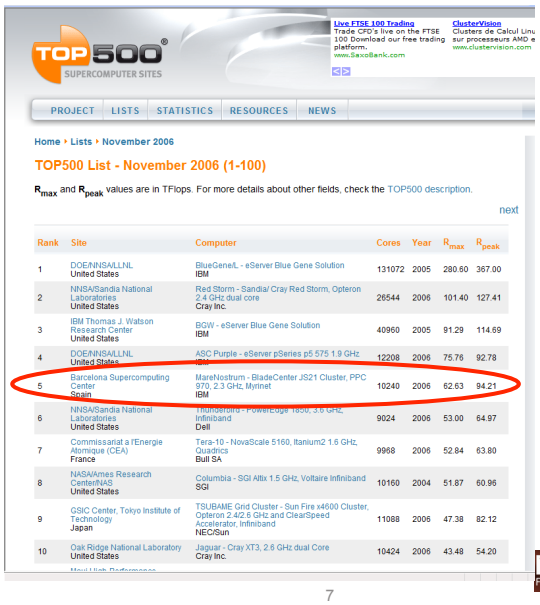
EGEE SW fed. Grid State Map

***GridMap* Prototype – Visualizing the "State" of the Grid**



Latest SAM results, Site Status, for 'OPS' VO, 06 Mar 2008 11:29 GMT.
Size of site rectangles is number of CPUs from BDII.
Certified Production sites of 'SouthWesternEurope' region.

EGEE: Access to some of the TOP500



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Endoscopic Capsule

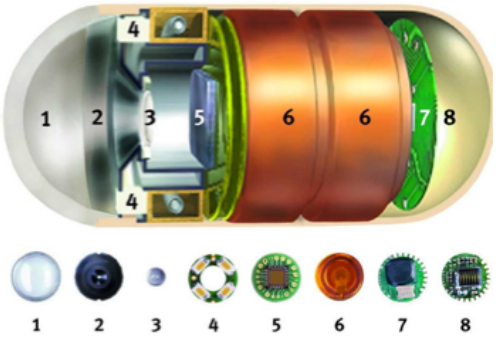


Fig. 1. Wireless endoscopic capsule. 1: Optical dome. 2: Lens ho
4: Illuminating LEDs. 5: CMOS imager. 6: Battery. 7: ASIC
8: Antenna.

[redacted]

Endoscopic Capsule

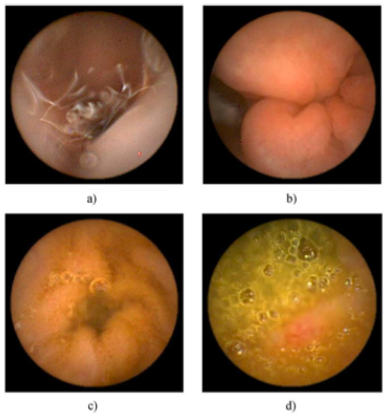


Fig. 2. Examples of endoscopic capsule images for the four different topographic zones. (a) Zone 1 (entrance) image. (b) Zone 2 (stomach) image. (c) Zone 3 (small intestine) image. (d) Zone 4 (large intestine) image.

EC data is growing fast !

- Number of E centers is ris
- Time of man demand
- New process
- Large scale i WILL be nee

Is Grid Computing a Solution ?

Capsule Endoscopy: Small is Effective

The global capsule endoscopy market is expected to grow at a CAGR of 26.3% during 2008 – 2015, to reach sales of $767.5 million in 2015.

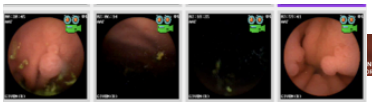
FOR IMMEDIATE RELEASE

PR Log (Press Release) – Dec 14, 2009 – The global capsule endoscopy market was valued at $149.8 million in 2008. Driven by increasing awareness of the advantages of this device over traditional endoscopes and its increased utilization as the first line of diagnosis for small bowel disorders, this market is expected to grow at a CAGR of 26.3% during 2008 – 2015, to reach sales of $767.5 million in 2015. With only 4 companies in the market at present and a high proportion of individuals suffering from gastrointestinal disorders, this under-penetrated market will provide huge growth opportunities for small and emerging companies that come up with an innovative product offering.

Endoscopy has been in use for almost three decades now. Traditionally, endoscopes used fiber optics and a powerful lens system that also utilized a light source to illuminate and visualize the interiors of body cavities and joints. The endoscopic procedure, 30 years since its inception, still remains a painful procedure to the patient. The other major drawback that the flexible endoscopes or rigid endoscopes could not address in these 30 years was visualization of the small intestine. The small intestine remained the final frontier for endoscopic instruments; until the advent of Capsule Endoscopy (CE).

This analysis was taken from a research paper published by GlobalData, to download the full Research Paper for free, click below:

•http://www.prlog.org



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CV method for EC video processing

628 IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, VOL. 16, NO. 5, MAY 2006

MPEG-7 Visual Descriptors—Contributions for Automated Feature Extraction in Capsule Endoscopy

***Abstract*—Recent advances in miniaturization led to the development of what is now called the endoscopic capsule. This small device is swallowed by a patient and films the whole gastrointestinal tract, allowing the detection of abnormalities. Currently, a doctor typically needs up to two hours to analyze a full exam, so automation is desirable. This paper presents a methodology for measuring the potential of selected visual MPEG-7 descriptors for the task of specific medical event detection such as blood, ulcers. Experiments show that the best results are obtained by the *Scalable Color* and *Homogenous Texture* descriptors, especially if only relevant coefficients are used.**

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CV method for EC video processing

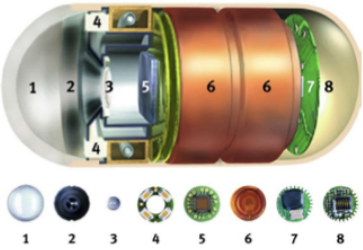
IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 27, NO. 1, JANUARY 2008

Automated Topographic Segmentation and Transit Time Estimation in Endoscopic Capsule Exams

J. P. Silva Cunha*, *Senior Member, IEEE*, M. Coimbra, *Member, IEEE*, P. Campos, and J. M. Soares

***Abstract*—Endoscopic capsule is a recent medical technology with important clinical benefits but suffering from a practical handicap: long exam annotation times. This paper proposes and compares two approaches (Bayesian and support vector machines) that can be used to segment the gastrointestinal tract into its four major topographic areas, allowing the automatic estimation of the clinically relevant gastric and intestinal sections and corresponding transit times. According to medical specialists, this can reduce exam annotation times by up to 12% (15 min). This automatic tool has been integrated into our CapView annotation software that is currently being used by three medical institutions.**

***Index Terms*—Capsule endoscopy, MPEG-7, support vector machines (SVMs), video annotation.**



CV method for EC video processing

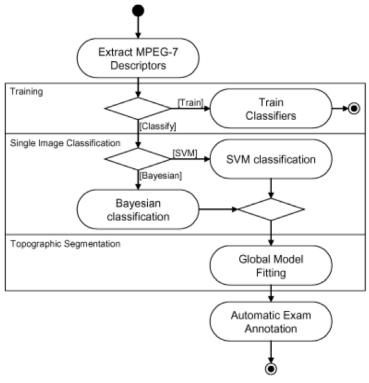


TABLE I
DATASET DETAILS— ZONE 1: ENTRANCE; ZONE 2: STOMACH; ZONE 3: SMALL INTESTINE; ZONE 4: LARGE INTESTINE

Nr. Patients	Total frames	Avg. frames per exam	Image Resolution
60	3.6 million	60,000	256x256
Avg. Frames Zone 1	Avg. Frames Zone 2	Avg. Frames Zone 3	Avg. Frames Zone 4
86	3974	31331	20004

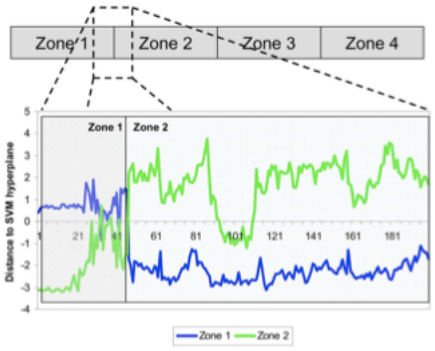
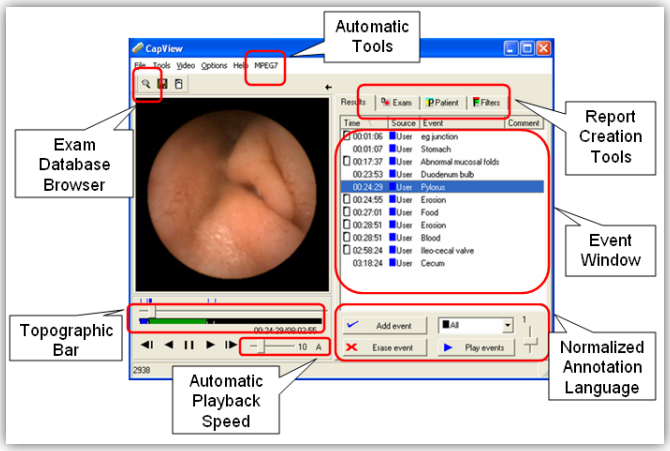


TABLE II
MEDIAN ERRORS OF THE TOPOGRAPHIC SEGMENTATION—E(12): ESOGASTRIC JUNCTION ERROR; E(23): PYLORUS ERROR; E(34): ILEO-CECAL VALVE ERROR

		Median Error (images)			
		$E(z_{12})$	$E(z_{23})$	$E(z_{34})$	Total
SVM	SC Lin	60	326	2689	3021
	SC Poly	2	211	1070	1285
	SC Rbf	9	704	1902	2615
	HT Rbf	15	647	1815	2477
	SC+HT Rbf	11	295	1322	1630
Bayes.	L1_SC	7	725	1548	2281
	Mult_SC_Gp	2	2345	1037	3383
	Mult_SC_NLp	3	948	1187	2138

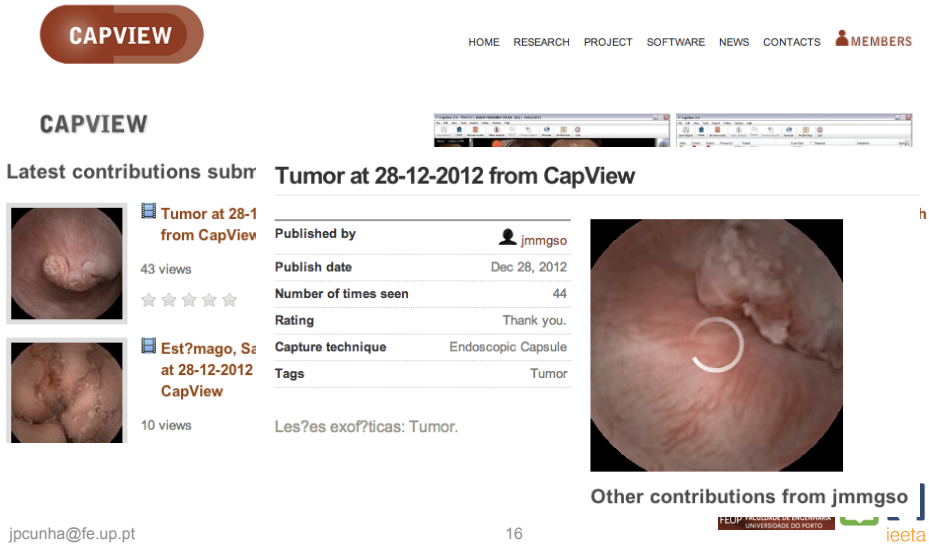
CV method for EC video processing



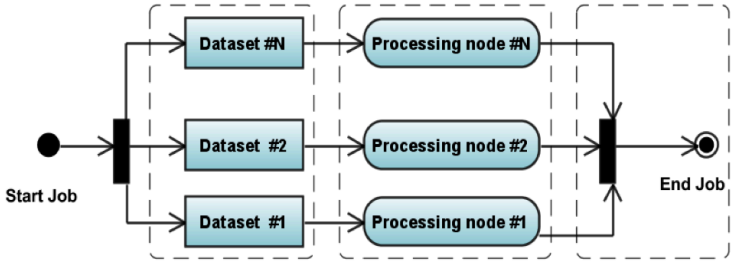
Available on CapView

- Can take 2 hours for a single video

Capview.org CV in EC community



How can we use Grid/Cloud to speed-up ?



MAGI Portal

- MAGI: Medical Applications Grid Portal

- We could reduce ~5x the processing time (25 min)

Conclusions

- EC is a fast (~25%/y) growing medical procedure
- Manual review will become impossible = We need computational tools
- These tools can be complex and computer demanding = single computers will not be enough
- Grid/Cloud computing is a powerful infrastructure that can be useful for EC massive data processing
- Grid/Cloud computing can be a solution to the expected growth of computational power needed in EC