



Visual
Information

P. Bhowmick

Visual Information Processing

Theories and Practice at IIT KGP

Partha Bhowmick

CSE, IIT Kharagpur

JOINT RESEARCH WORKSHOP
IIT KHARAGPUR & BEN-GURION UNIVERSITY, ISRAEL
23-24 FEB 2016



Faculty Members

Visual Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni

1 P. Bhowmick (CSE)

2 P. P. Das (CSE)

3 S. K. Ghosh (CSE)

4 A. K. Majumdar (CSE)

5 Pabitra Mitra (CSE)

6 Pralay Mitra (CSE)

7 J. Mukhopadhyay (CSE)

8 S. Sural (CSE)

9 P. K. Biswas (ECE)

10 R. Layek (ECE)

11 S. Bhattacharya (SMST)

12 M. Manjunath (SMST)

13 S. Chakrabarti (GSST)

14 R. Guha (SCC)

15 M. K. Maiti (BT)



Research Areas

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni

- 1 Digital Geometry & Topology
- 2 Combinatorial Image Analysis
- 3 Computer Graphics
- 4 Image and Video Processing
- 5 Computer Vision and Robotics
- 6 Document Image Processing
- 7 Medical Image Processing & Assistive Technology
- 8 Remote Sensing
- 9 Cognitive Processing
- 10 Medical Instrumentation



Digital Geometry & Topology I

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni

- 1 Discretization techniques
- 2 Digital straight line, circle, plane, sphere, ...
- 3 Digital straightness, digital circularity, ...
- 4 Theory of fractions, elementary number theory, word theory, graph theory, ... (in the context of DG&T)
- 5 Pixel & voxel topology
- 6 Isothetic polygons & polytopes, orthogonal hulls & skulls, ...
- 7 Medial axis & MAT, metrics & digital distances, ...
- 8 Image compression, encoding, ...



Combinatorial Image Analysis I

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

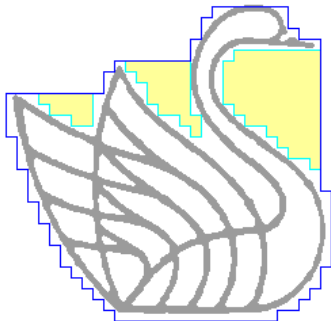
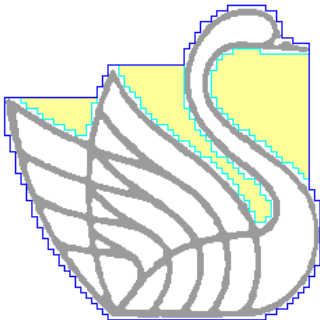
Docu

Med

Remo

Cogni

Isothetic covers and hulls





Combinatorial Image Analysis II

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

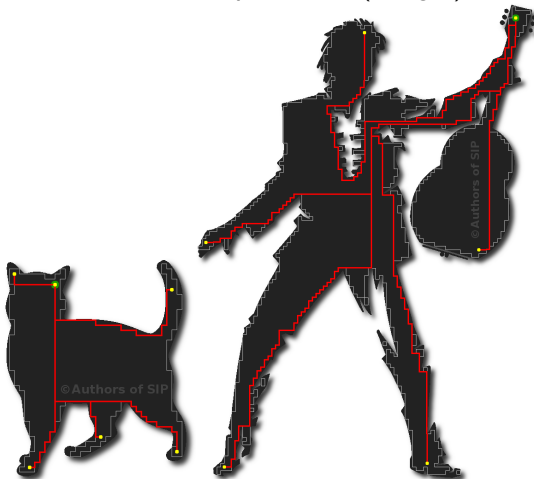
Docu

Med

Remo

Cogni

Shortest isothetic paths— $O(n \log n)$ time





Combinatorial Image Analysis III

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

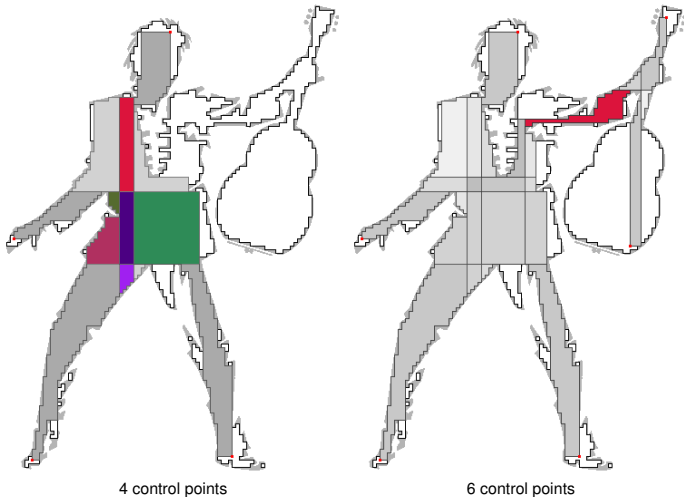
Docu

Med

Remo

Cogni

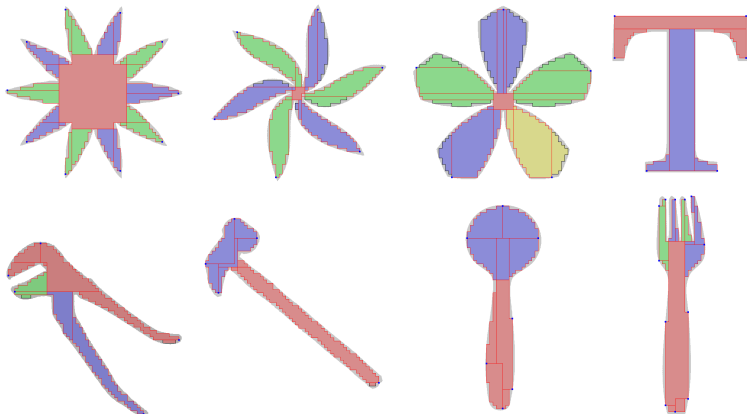
Family of shortest isothetic paths





Combinatorial Image Analysis IV

Application in segmentation



Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Combinatorial Image Analysis V

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

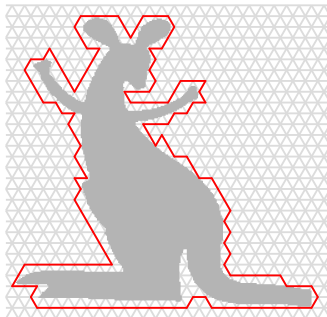
Docu

Med

Remo

Cogni

Triangular isothetic covers





Combinatorial Image Analysis VI

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

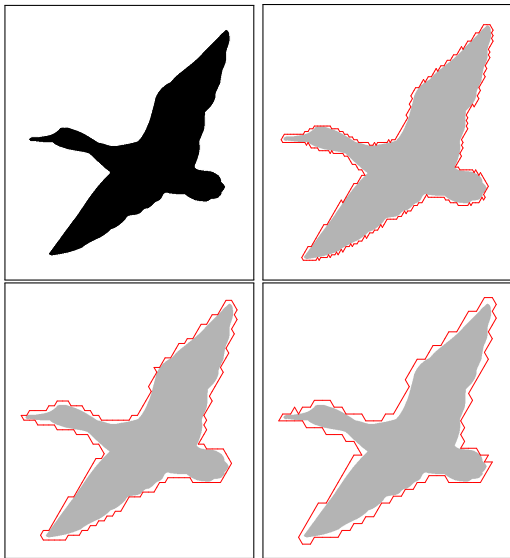
Robot

Docu

Med

Remo

Cogni





Combinatorial Image Analysis VII

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

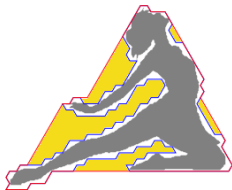
Docu

Med

Remo

Cogni

Triangular hulls (& shape analysis!)



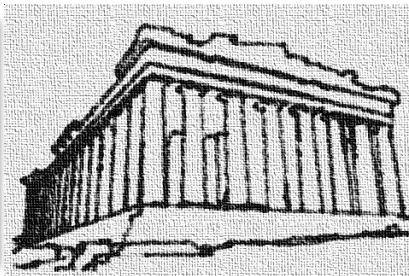
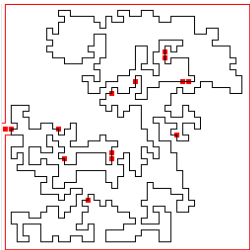


Computer Graphics I

Visual
Information

P. Bhowmick

Algorithmic art



Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Computer Graphics II

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

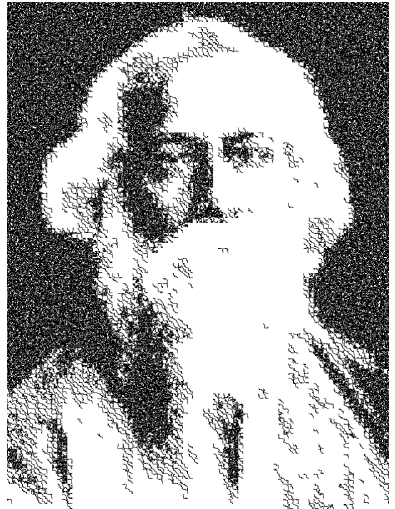
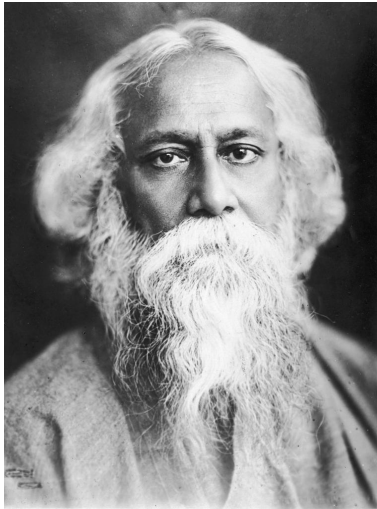
Robot

Docu

Med

Remo

Cogni





Computer Graphics III

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

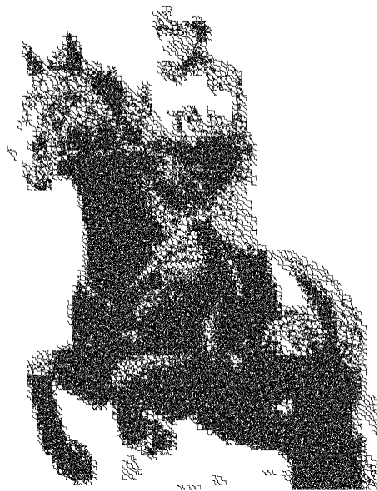
Robot

Docu

Med

Remo

Cogni





Computer Graphics IV

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

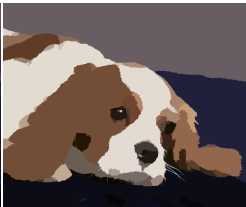
Remo

Cogni

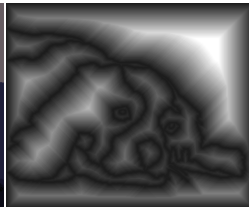
Digital circlism...



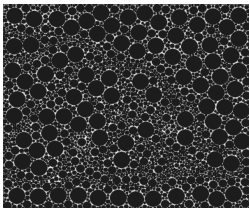
input



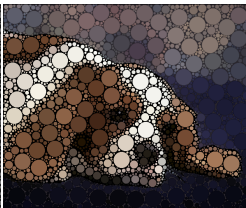
segmentation



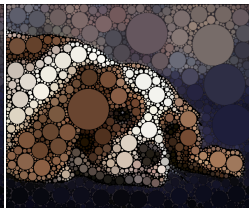
EDT



$r \in \{20, 10, 5, 3, 2\}$



circle art



another denom.



Computer Graphics V

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

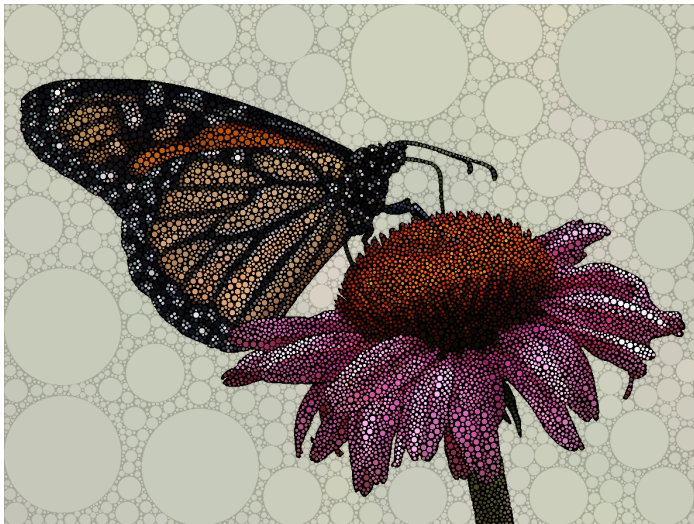
Robot

Docu

Med

Remo

Cogni





Computer Graphics VI

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

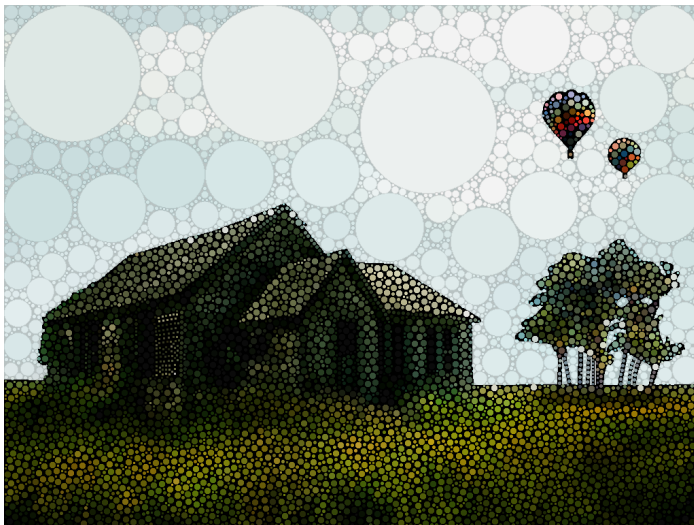
Robot

Docu

Med

Remo

Cogni





Computer Graphics VII

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni





Computer Graphics VIII

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni

Digital potteries





Computer Graphics IX

3D segmentation

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

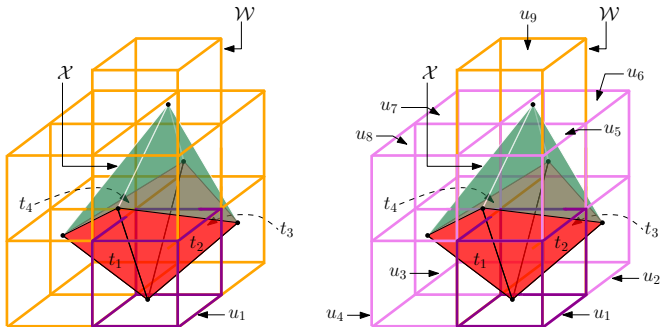
Robot

Docu

Med

Remo

Cogni



Topological equivalence between a triangulated surface and an isothetic polyhedron.



Computer Graphics X

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

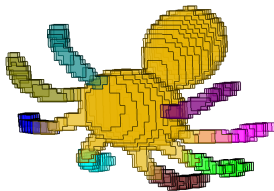
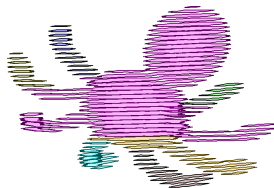
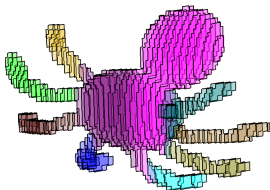
Robot

Docu

Med

Remo

Cogni





Computer Graphics XI

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

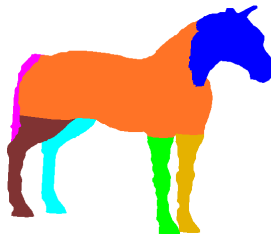
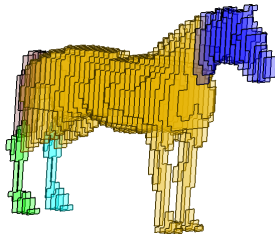
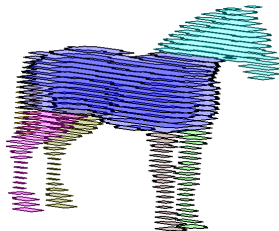
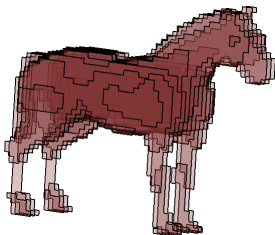
Robot

Docu

Med

Remo

Cogni





Computer Graphics XII

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

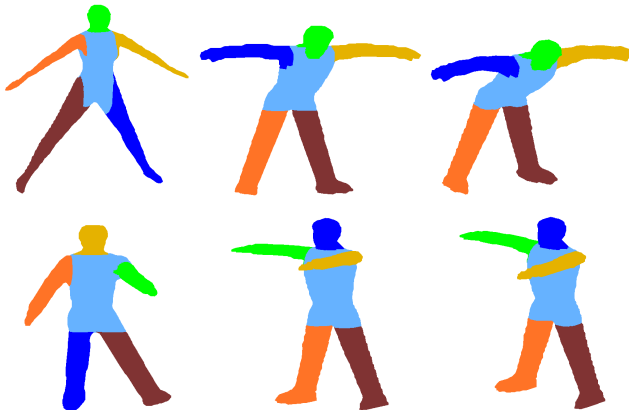
Robot

Docu

Med

Remo

Cogni





Computer Graphics XIII

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

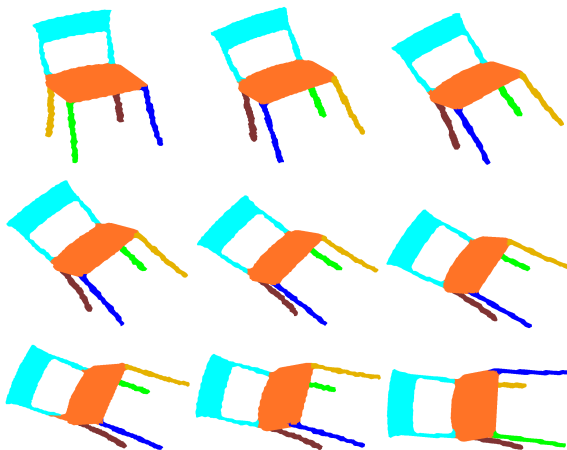
Robot

Docu

Med

Remo

Cogni





Computer Graphics XIV

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni

3D Printing

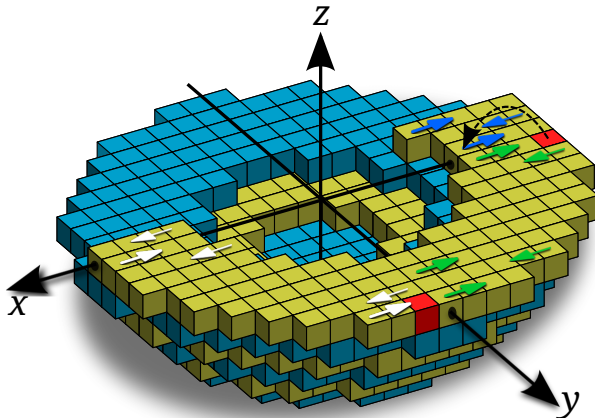


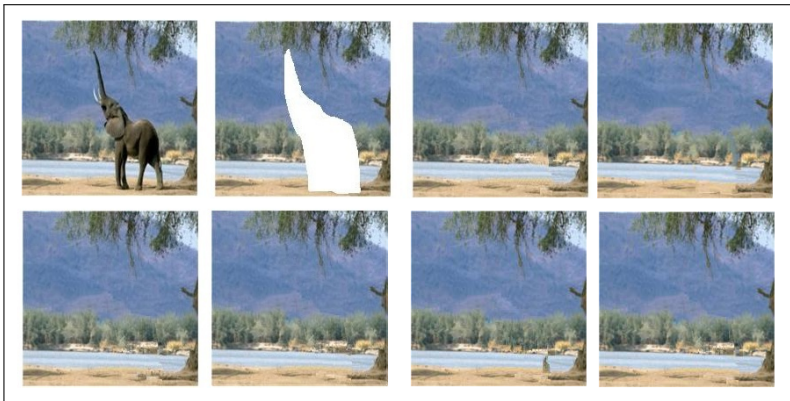


Image and Video Processing I

Visual
Information

P. Bhowmick

Inpainting



Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

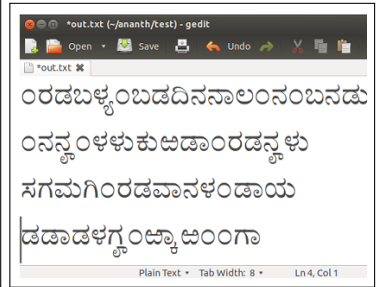
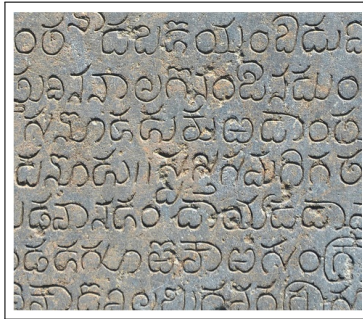
Remo

Cogni



Image and Video Processing II

Inscriptions & word spotting



Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Image and Video Processing III

Visual
Information

P. Bhowmick

Digital restoration



Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Image and Video Processing IV

Visual
Information

P. Bhowmick

Straightness features



Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Image and Video Processing V

Dance analysis with transcription in *Labanotation*

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni

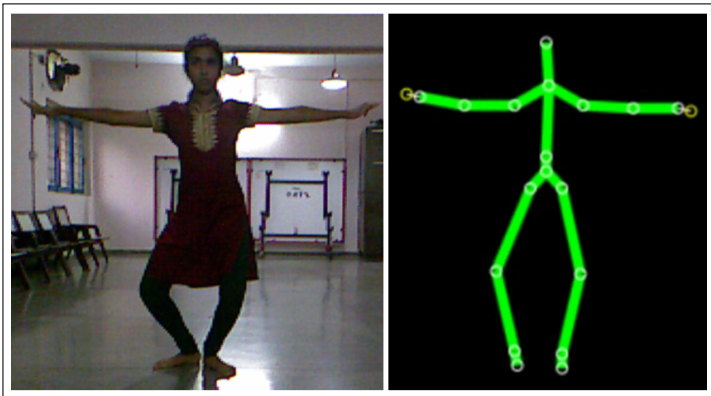




Image and Video Processing VI

3D reconstruction by 1-Kinect 2-mirror depth imaging

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

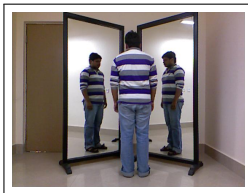
Robot

Docu

Med

Remo

Cogni





Computer Vision and Robotics I

Ultrasonic Vision for Visually Impaired / Blind

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

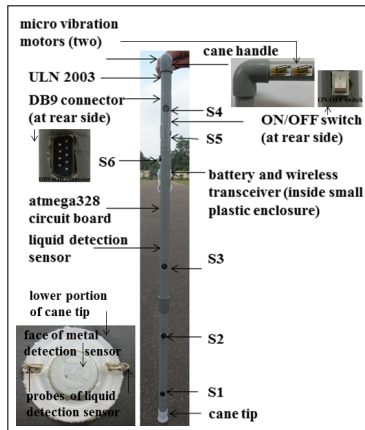
Robot

Docu

Med

Remo

Cogni





Computer Vision and Robotics II

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

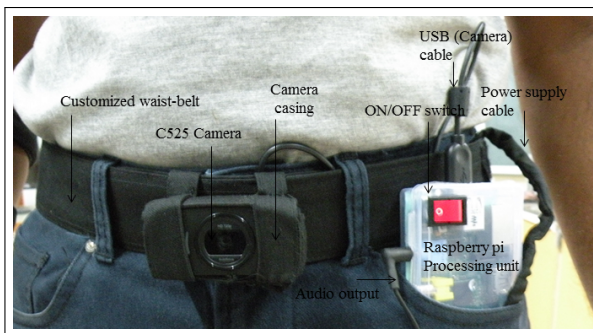
Robot

Docu

Med

Remo

Cogni





Computer Vision and Robotics III

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

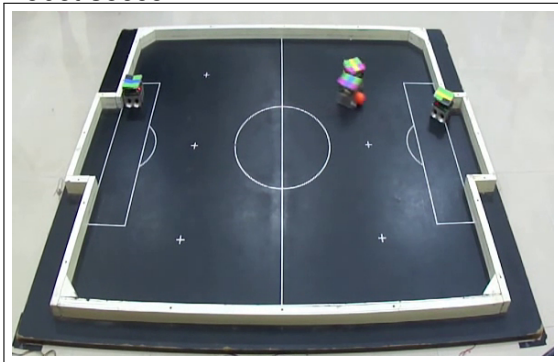
Docu

Med

Remo

Cogni

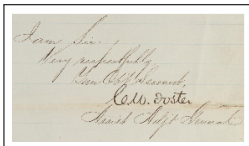
Robot soccer



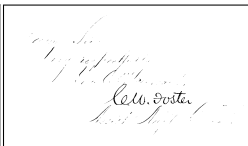


Document Image Processing I

Document image binarization



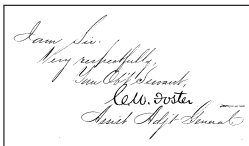
Input image



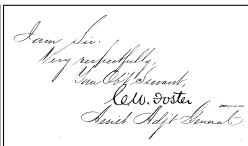
Otsu method



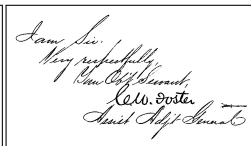
Niblack method



Sauvola method



Moghaddam method



Our method

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Document Image Processing II

Document image cleaning



সর্বস্ববিদৌর্গ বালি তবু নাহি হটে।
অশোক কিংশুক যেন বসন্তেতে ফটে ॥

শ্রীশ্রী বালেন, মিত্র, কহিলে সকল।
বালিকে মারিয়া করি তোমাকে প্রবল ॥

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Document Image Processing III

Visual Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni

Document understanding

Takeover Frenzy in Telecoms: the Case of MCI WorldCom Part Two: Financial Bids

PAUL STODHAM, EAP — *Executive School of Management, Oxford*

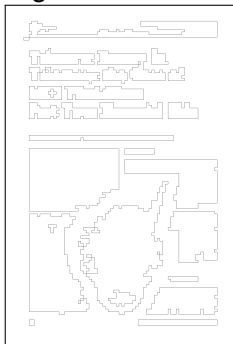
Introduction

The first of this Case Study focuses on the overall acquisition and subsequent bids for MCI's communications made by BT, WorldCom and CTS. It then focuses on the details of the bid made by BT to acquire MCI and the subsequent financial bids made by BT and WorldCom to acquire MCI. The second part of the study focuses on the bid made by BT to acquire MCI and the subsequent financial bids made by BT and WorldCom to acquire MCI. The study concludes with a list of recommendations for MCI to improve its financial position.



The BT Bid

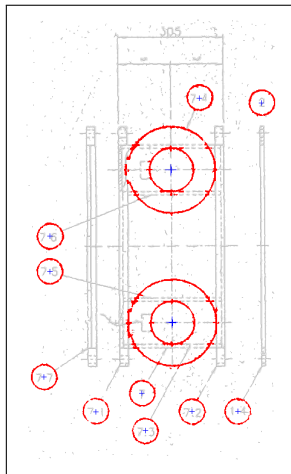
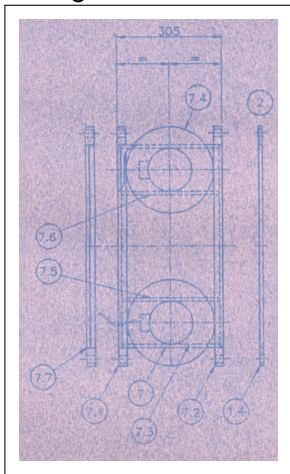
In 1996, BT acquired a 20 per cent stake in MCI, and in 1997, BT acquired a 50 per cent stake in MCI. The acquisition was completed in 1997.





Document Image Processing IV

Arc segmentation



Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Document Image Processing V

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

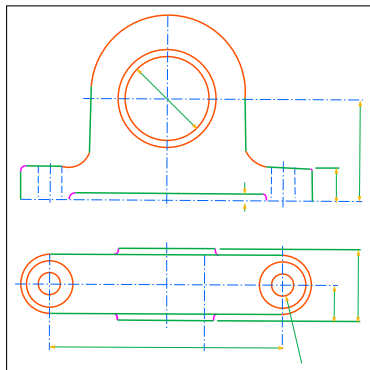
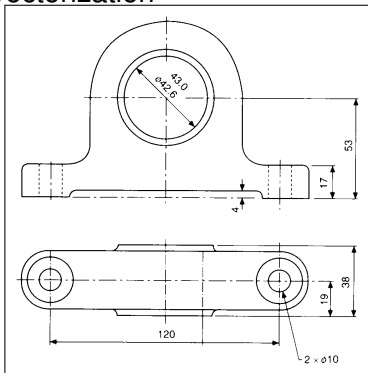
Docu

Med

Remo

Cogni

Vectorization





Medical Image Processing & Assistive Technology I

Visual Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

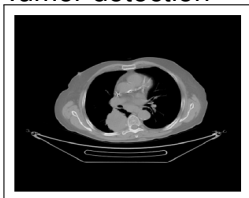
Docu

Med

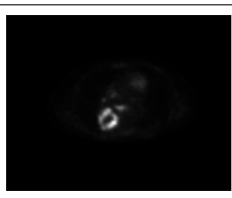
Remo

Cogni

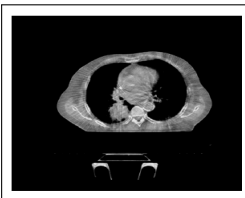
Tumor detection



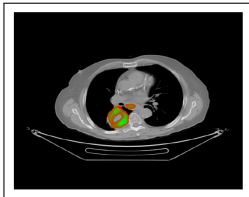
CT-Pre-treatment



PET-Pre-treatment



CBCT-Pre-treatment



CBCT Registered with PET-CT



CBCT-I



CBCT-I registered with CBCT-0

(Tomography: PET = Positron Emission, CT = Computed, CBCT = Cone Beam Computed.)



Medical Image Processing & Assistive Technology II

Visual Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

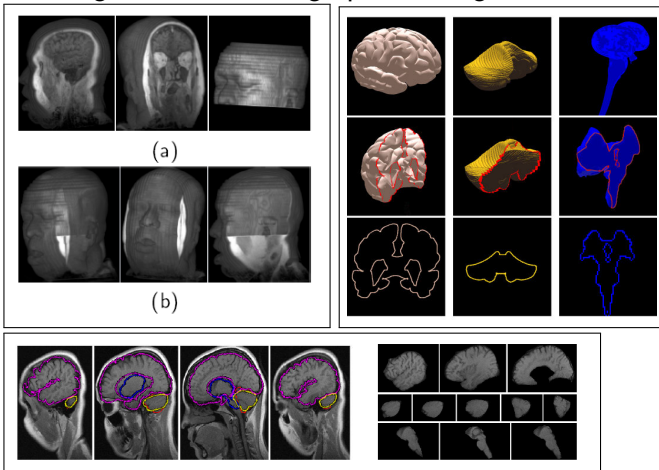
Docu

Med

Remo

Cogni

Model-guided brain image processing





Medical Image Processing & Assistive Technology III

Visual Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

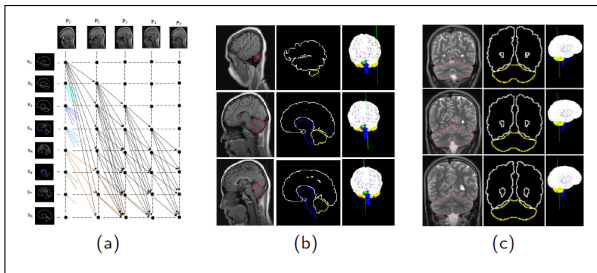
Robot

Docu

Med

Remo

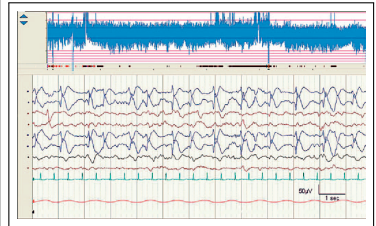
Cogni





Medical Image Processing & Assistive Technology IV

Neonatal epilepsy checking by EEG



Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Remote Sensing I

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

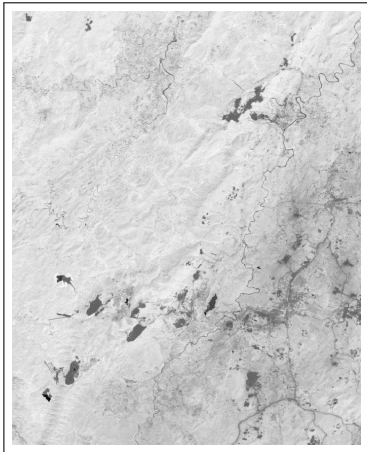
Docu

Med

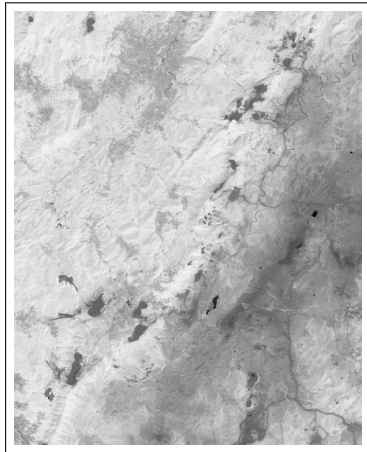
Remo

Cogni

Satellite imaging



NDVI-2005



NDVI-2014



Remote Sensing II

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

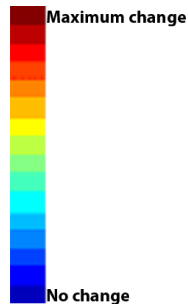
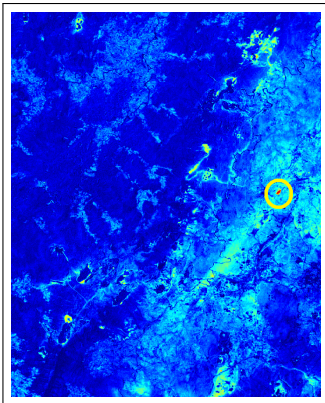
Robot

Docu

Med

Remo

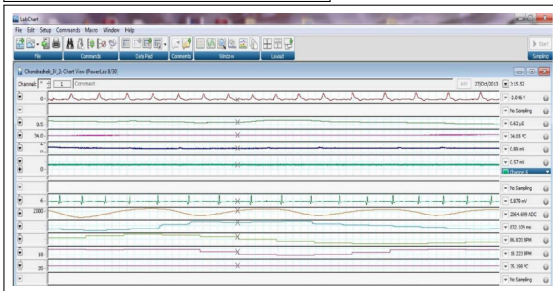
Cogni





Cognitive Processing I

Emotion Analysis (by biomedical signal)



Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Cognitive Processing II

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

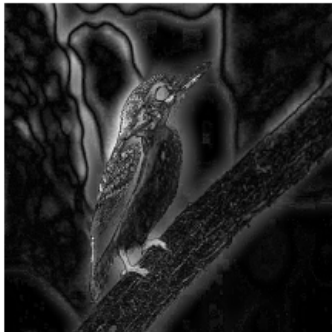
Docu

Med

Remo

Cogni

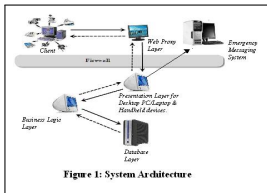
Visual saliency



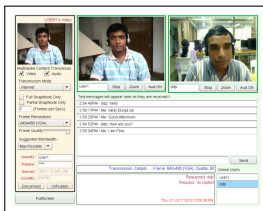


Cognitive Processing III

Softwares



System architecture



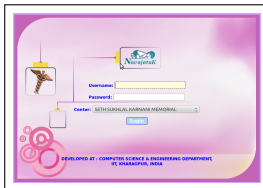
eBaithak



Telemed system



IP evaluation



Neonatal telemed

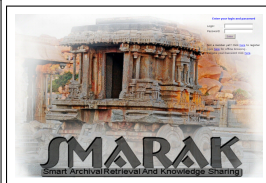


Image retrieval

Visual Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni



Cognitive Processing IV

Visual
Information

P. Bhowmick

Geo-Topo

Combi

Graphics

Img-Vid

Robot

Docu

Med

Remo

Cogni

And many such...

Thank you!