SSIP 2015

Projects

Szeged July 2015

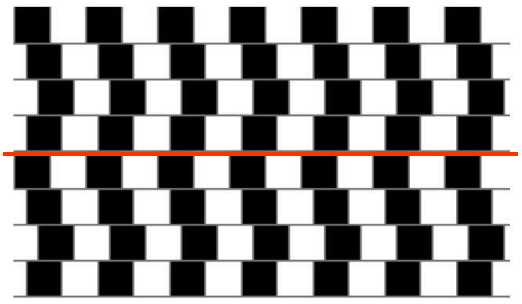
Guidelines -> Roadmap

Team work

- Gopher
- Scientist/ researcher
- Programmer/ coder
- Documenter/ publicist
- Manager

You will be assessed in terms of:

- Ability to function as a team
- Scientific originality
- Use of resources
- Demonstration of function
- Quality of coding
- Quality of documentation
- Interest and imagination of Web pages

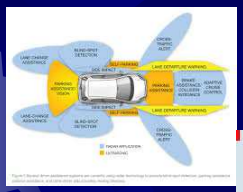


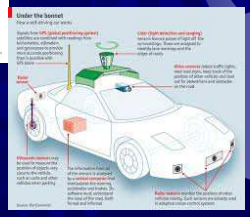
Are the horizontal lines parallel or do they slope?

Project 1. Bicycle detection at street crossings

Specification of the task:	Bicycle usage is becoming more common lately. In order to develop the city infrastructure, which is appropriate for growing bicycle population, statistical information about number of cyclist in given part of the city is required. Using video information from street crossings can be used to calculate the number of cyclist in each city part. The goal of this project is to develop a method for bicyle counting from a video. The video should be taken at a street crossing.
Availability of test/train data if required:	You can easily capture video information.

Bicycle detection at street crossings





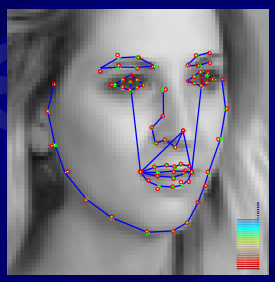
Project 2. Butterfly recognition

Specification of the task:	Build a butterfly recognition framework which returns a list of potential matches ranked according to the similarity to a query image. The problem involves several subtasks: - coarse localization of the butterfly, - segmentation (hint: symmetry, color, shape might be representative features aiding segmentation), - appearance representation and matching (hint: analyzing the dataset with respect to discriminative features might be necessary). - evaluation: e.g. how recognition performance depends on the size of the training dataset, which species are similar to each other (confusion). Please do not perform experiments on live or on captured or on not-live-anymore-but-captured butterflies. Additional butterfly data (beyond the provided link) can be found easily using search engines.
Availability of test/train data if required:	http://www.comp.leeds.ac.uk/scs6jwks/dataset/leedsbutterfly/
Contact:	Csaba Beleznai

Project 3. From Statistical Constraints to Global Regressors

Specification of the task:	Accurate localization of landmark points is a recurrent problem with several applications in computer vision and medical imaging. Statistical shape models combine local predictions obtained independently for each landmark with statistical priors controlling their spatial relations. Some recent works have chosen to replace the statistical shape model with regressors that operate globally, learning the constraints in an implicit manner. This global strategy improves robustness at the expense of local accuracy and training set size, but highlights the fact that landmark predictions are not independent of each other and their correlations might carry useful information. The aim of this project is to compare a regression model with a statistical shape model under the sama experimental settings and evaluate the impact of imposing additional constratings on the individual landmark predictions, so that they are not treated independently.
Availability of test/train data if required:	http://www.milbo.org/muct/
Proposed readings:	http://fsukno.atspace.eu/Thesis.htm http://link.springer.com/article/10.1007/s11263-013-0667-3

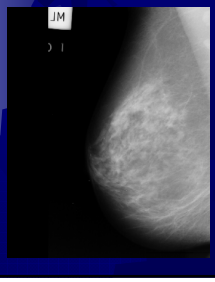
From Statistical Constraints to Global Regressors

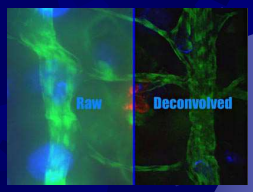


Project 4. Image Restoration by Using Different Deconvolution Algorithms

Specification of the task:	An image is always degraded during its formation, by the imperfect imaging system. Students should take into account these different imperfectness by using any implicit or explicit knowledge about Point Spread Function (PSF) of the imaging system and try to 'clean' image. Knowing or deriving some estimation of noise in the image is highly desireble. Different deconvolution algorithms should be applied to an image and see their abilites and limitations. Other techniques known to students should be applied as well.
Availability of test/train data if required:	Objects for application of deconvolution procedures are medical images-mammograms http://www.mammoimage.org/databases/
Contact:	Slavoljub Mijovic

Image Restoration by Using Different Deconvolution Algorithms





Project 5. Blood vessel detection in fundus photographs

Specification of the task:	Diabetic retinopathy (DR) is one of the leading disabling chronic diseases, and one of the leading causes of preventable blindness in the world. In order to achieve early diagnosis of diabetic retinopathy a major effort will have to be invested into screening programs. Fundus imaging has an important role in diabetic retinopathy detection and monitoring because eye fundus is sensitive to vascular diseases. The goal of this project is to develop a method for segmentation of blood vessels in fundus photographs.
Availability of test/train data if required:	You are provided with 50 fundus photographs from people with and without symptoms of diabetic retinopathy. For each image you will get a ground truth image with blood vessels marked by an expert. Ground truth images can be used for algorithm development and algorithm testing.
Proposed software:	MATLAB

Blood vessel detection in fundus photographs

Project 6. Detection of Roadside Vegetation

Specification of the task:	Detecting vegetation in robotics is used for navigating autonomous vehicles through on-road and off-road scenarios. For autonomous vehicles not all vegetation-like obstacles need to be avoided, e.g., a vehicle can drive over tall grass and not avoid it. In urban areas we can detect roadside vegetation and use that information for maintaining roadside infrastructure (mowing the grass and navigating the mower) and for traffic safety for detecting vegetation-like obstacles in traffic and to detect if vegetation is ocluding traffic signs or traffic lights. Many methods for vegetation detection are using Near Infrared images because chlorophyl rich vegetation reflects NIR light and having that part of the spectrum makes the classification problem easier. On the other hand, if you don't have a NIR camera you have to work only with the visible part of the spectrum and that is the case with this project. Our database is recorded via color camera and the developed method in this project will have to be based on using features from the visible spectrum. You need to develop a method for automatic detection of roadside vegetation. Based on the detected areas of vegetation as a result you will have images segmented into vegetation and non-vegetation areas.
Proposed readings:	Structure overview of vegetation detection. A novel approach for efficient vegetation detection using an active lighting system docs.mipro-proceedings.com/cis/CIS_22_2499.pdf

Detection of Roadside Vegetation

Project 7. Recognition of doors and steps

- Help blind people navigate by using images from their mobile phone (or webcam) by recognizing **doors, steps**, etc.
- Build object database
- Consider invariance
- Difficulty: medium to hard

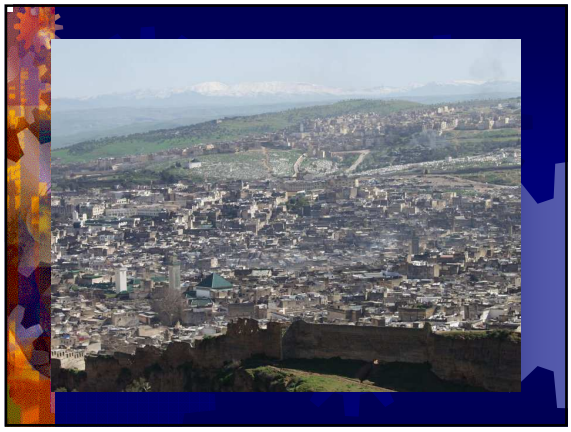
Project 8. Counting objects

- Counting windows
- Input: photo of a building
- Task detect and count windows
- Output: a number plus indication of where the windows are
- Difficulty: medium

View from my window

Alternative Count roofs

- **Counting roofs.**
- **Input: a digital photo of roofs**
- **Task: count all of roofs in the image, give every roof a unique id (number)**
- **Output: identifies roofs.**
- **Difficulty: hard**



Project 9. World Cup Highlights

- Input: video sequence of part of football match
- Aim to detect key events such as goals, fouls (or diving)
- Output: statistics of match
- Remarks: Difficulty medium to hard.
- Note 'Use of camera tracking to observe if balls crosses line'

Football matches in history

Project 10: Dental implantology

- Easy: Count the number of teeth on a CT of a jaw bone.
  - Input: CT of the jaw (3D volumetric data) Files in dicom format.
  - Output: the number of teeth on the image.
- Medium: Determine the missing teeth of the patient from a CT image.
  - Input: CT of a jaw bone
  - Output: A list of missing teeth. Eg.: teeth number 14, 23, 24, 25 are missing.
- Hard: Fill in the missing teeth of a patent with surface tooth models from a database. The task is to align a complete/healthy dental arch to the input image based on the patient's existing teeth. Rotation, location and scale should be taken into account.
  - Input: CT of a partially edentulous patient + surface models of all 32 teeth (database, different patent)
  - Output: combined image of the patients own teeth and the filled in teeth
- Input will be provided

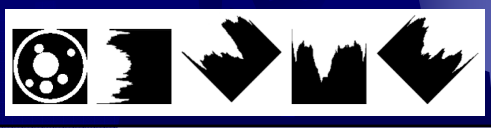
Project 11: Liver vessel segmentation

- Background: Liver vessels are examined by various 3-dimensional imaging techniques in the clinical practice (CT, MRI, US). The accurate segmentation of liver vessels is very important because the liver has a complex vessel system (portal vein, hepatic vein, ...).
- Challenges: The different imaging techniques have very different image characteristics and artifacts, there is no general solution. The different vessel structures can run very close to each other, so segmentation methods usually leak form one vessel to another.
- Goal: To segment liver vessels in CT (moderate difficulty), MRI (medium difficulty), and US images (high difficulty). In the first two cases the image involves the whole liver, so the problem can be simplified by manual delineation of the volume of interest.
- Data: 6 image sets including the contrast-enhanced abdominal CT and MRI, and the 3D US image of the same liver. Since the image sets belong to the same patient it is possible to compare the segmentation results belonging to the different modalities.
- Input will be provided

Liver vessel segmentation

Project 12: Binary tomography

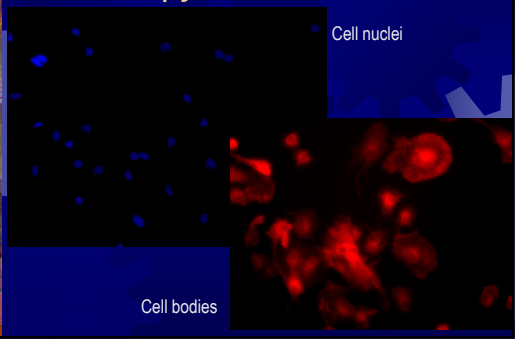
- Calculate projections of binary images in few directions (MATLAB, ImageJ: Radon transform)
- Try to reconstruct the original image from the projections (can be solved by optimization)
- Improve reconstruction quality by using prior knowledge: binary values, homogeneity, structural information (Discrete Tomography)



Project 13: Microglia analysis using microscopy

- Measuring area and perimeter of cells in fluorescent microscope images
  - Microglia are special cells of the central nervous system. Some research in cell biology requires to calculate area and perimeter of microglia in fluorescence microscopy images, which makes their correct segmentation necessary.
  - The aim of this project is to find a method that automatically performs both the segmentation and the measurements.
  - Two types of images are taken from each cell culture under different fluorescence lights: blue is used for making only cell nuclei visible, while the whole cell bodies are shown under red light.
  - Cells on the image margins being not completely visible must be eliminated before the calculations. Furthermore, if two or more cell bodies seem to be merged as one object in the image (two nuclei but seemingly one cell body), then those must be also ignored.
  - Input will be provided

Microglia analysis using microscopy



Summary

1. Bicycle detection
2. Butterflies
3. Stat. constraints, models
4. Deconvolution
5. Blood vessel detection
6. Roadside vegetation
7. Doors and steps
8. Counting objects
9. Football
10. Dental
11. Liver vessel segmentation
12. Discrete Tomography
13. Microglia
14. suggestions

Now….

- Take a project selection form
- Now select your three favourite projects
- Order them - 1,2,3
- Write your name on the form
- Hand it in