### 於 **SSIP 2016** 24th Summer School on Image Processing 7-16 July, 2016, Szeged, Hungary

### Projects





#### 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. Tracking pedestrian trajectories in outdoor videos

| Specification of the task:                   | Detect pedestrians in videos from outdoor surveillance camera and track<br>trajectories of the moving objects<br>Further tasks can be:<br>- Classify moving objects (adult, child, stroller, wheelchair, scooter,<br>bicycle)<br>- Detect/ classify abnormal behaviour in the scene<br>Challenges: weather conditions, light changes during the day, busy<br>junctions, bicyclists, occlusions (trees and stands), etc. |
|--|---|
| Availability of test/train data if required: | http://homepages.inf.ed.ac.uk/rbf/FORUMTRACKING/<br>https://motchallenge.net/data/MOT16/<br>https://motchallenge.net/data/ECCV_2016_Challenge/<br>You can also easily capture video information.  |

# Project 2. Evaluation of the quality of an imaging system

| Specification of the task:                   | Any imaging system influences the 'perfect' input image, to which we<br>have not direct access, in non-desired way. These non-desired effects<br>are characterized and modeled as Point Spread Function (PSF) and<br>noise.<br>Our first task is to estimate the input 'perfect' image, by using our<br>imperfect or corrupted image and any knowledge we have about PSF<br>and noise. (medium difficulty) |
|--|--|
|  | The second task is to try to get a synthetized image of the breast phantom by using the real image of it. (high difficulty).   |
| Availability of test/train data if required: | The images we are dealing with were obtained in a CR mammography system in the Clinical Center in Podgorica.   |
| Contact:                                     | Slavoljub Mijovic  |

### Evaluation of the quality of an imaging system



# Project 3. Detection of roadside vegetation

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

#### **Detection of Roadside Vegetation**



# Project 4. 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 5. 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



#### 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 6. OCT image analysis

- OCT = Optical Coherence Tomography
- Aim: detect, segment, and quantify OCT features in retina scans
  - Subretinal fluid, Cysts, HRD (hyperreflective dots)



### Project 7. Sport highlights

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



#### Football matches in history





### Project 8: 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)
- More challenges: noisy projection data



## Project 9: 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



Cell bodies

### Project 10: Estimating roulette game outcome based on multiple images

- Use HD videos posted on YouTube to get video sequences, such as https://youtu.be/0Zj\_9ypBnzg (downloading using a downloader plugin, such as 1click YouTube Video Downloader)
- Estimate and track roulette pose (color and section layout)
- Estimate the ball position speed
- Estimate the rotation speed of the roulette wheel
- --> Estimate the section of the roulette wheel in which the ball will make contact first. Evaluate accuracy on multiple videos.

#### Project 11: Rubik's cube recognition and solution generation from multiple views

- Record images of a Rubik's cube from multiple angles and detect the current state of the cube
  - Edge detection: an initial detection of the cube object
  - Color detection: scan the color cells for each visible side
  - Feature extraction: detect all small squares and cube features (3D localization and orientation)
  - Aggregate features from multiple views to have complete information on all sides
- Use one of the several publically available solvers (such as http://leisureprogramming.blogspot.co.at/2015/05/rubikscube-solver-c.html) to generate steps for solving the cube
- Given an estimated pose, generate graphical overlay showing the solution hint for a next step

# Project 12: Detecting (near) planar regions in stereo image pairs

- Input
  - Two images of the same scene (buildings) taken by smartphones (Different viewpoint, nearly at the same time)
  - Different devices, sensors (Color differences may occour)
  - Camera calibration parameters are available
- Desired output
  - Segments in the image forming planar patches (in one of the images, patch correspondence between the image pairs is not necessary)





# Detecting (near) planar regions in stereo image pairs

- Application
  - Patch matching
    - http://www.inf.u-szeged.hu/rgvc/projects.php?pid=patchreg
  - Spatial stereo reconstruction
    - <u>http://www.inf.u-szeged.hu/rgvc/projects.php?pid=patchrecon</u>
- Idea
  - Detect ASIFT keypoints in the images
  - Try to find subset of corresponding points that are related by homography
  - Expand the region between the keypoints
- Other approaches are also welcome!
- Literature
  - Simon J.D. Prince. Computer Vision: Models, Learning, and Inference. Cambridge University Press, 2012. <u>http://www.computervisionmodels.com/</u> (eBook in PDF is available for free!)

### Project 13: Foamy events: understanding the universal laws of optimal space filling

#### Specification of the task



#### Availability of test/train data

Proposed software

Foams are complex cellular systems which by definition consist of at least two phases. These are an interesting class of materials, principally because their mechanical properties are not a linear sum of its components. Furthermore these materials are particularly useful as their properties can be tuned by adjusting the composition, size distribution and topology rather than their chemical make-up. This also means that their characterization requires quantitative measures and very advanced image processing still today not reliably enough to give full answers to many technologically relevant questions such as why is the beer foam collapsing faster in certain cases or how strong is an aluminum foam material to be used as a car component. The project will consist of two phases: 1. A conceptual decision on how time resolved 4D images will be treated and 2. which are the metrics that could reliably describe the topology and its temporal distribution.

A time resolved series of X-ray tomographic images will be provided. This is not simply a dummy data, but has a scientific relevance for the study of the physics in foam rheology.

ImageJ, matlab, MevisLab, iMorph



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Contact

### Foamy events: understanding the universal laws of optimal space filling



Labeled bubbles



Flow field & deformation tensor





### Project 14: Word puzzle recognition

- Recognize the characters and find the words in the puzzle
- Word list is given or its extraction can also be automated
- Different font types increase the difficulty

ADERTYWIOPAPROJECTSZXCVGRM UIOWISCONSINNXCVLMQWADTRIO GSISTERVRPBOMAWROCNEVELEDF XNVCIRDECKMNETICVDYRDNUALZ SGJLSMCWEATYARPTEDFGUHKTZM GRANOISYDLRTHRULSABDSRZWSM NYEUHJERVEFCMDOTSIWIIOHHTC ILKHDADVTIMMBOADNGRNKKCIIH DIVITDEHERIEHNMZQEJHNVRTJB DMHSDOAUPDLCXEKZHTVBCIDEWS EARPANRFRASUKGZCHFBDNMTLMU BFYGUTFBCEITSIYHQAWEATYRSP TKHFDCVBMMQETRPSIERECORGAU EDFSHJJODXCABLBOUQARWSHEQM WJNUJMHKOLIDLOLIIBABIESBTG

| ADRIEL<br>ADVENTURE<br>BABIES<br>BROTHERS<br>BUISY | CALEB<br>CEDRIC<br>CHERISH<br>CHRISTIAN | DAD<br>DAMON<br>DORAN<br>ETHAN | FAMILY<br>FUN<br>GREAT WHITE<br>GROCERIES<br>HOMESCHOOLED | JADON<br>LAUNDRY<br>LOVE<br>MARTIN<br>MOM | NOISY<br>ONE GIRL<br>PROJECTS<br>SISTER<br>TWINS | WET BEDDING<br>WISCONSIN<br>WORK |
|--|---|--------------------------------|---|---|--|----------------------------------|
| BUSY   | CUTE                                    | ELEVEN                         | HOMESCHOOLED  | MOM                                       | IWINS  |                                  |

ftgjyibsahahdrgahugdvjnchksfg shhiuasiyqqpenebcxhcgeifhkfkf fueireudihjdefhloiirktocitcra fygccagsjsdhpreyofrunwennuyax roakyrutyirugfgvilpajthhdryhs hdhrueujdffishuceylhdjdhitysu uduagsvsulududaejtriheeyaljjp aurdjneajidjkpscaeufllebneeoo rrotroilwaterneppqoadbwiliwft ksjjqjqtjsjiqwejsoheeoogtuwrc htiurtrwsnakejojowmmnpqcjcezo

| arctic   | deep   | octopus | turtle    | squid |
|----------|--------|---------|-----------|-------|
| atlantic | eel    | pacific | sting ray | whale |
| crab     | EAC    | shark   | sail fish | water |
| blue     | fish   | salt    | dark      |       |
| big      | indian | snake   | wave      |       |

ocean

# Project 15: Writer identification by handwriting

- Who is the owner of the handwritten text?
- Extract features and identify the writers!
- CVL public database can be used <u>http://www.caa.tuwien.ac.at/cvl/research/cvl-databases/an-off-line-database-for-writer-retrieval-writer-identification-and-word-spotting/</u>

"my universe": but now my mind has been opened to higher views of things.

Imagine a vast sheep of paper on which straight Lines, Triangles, Squares, Benbagons, Hexagons, and other figures, intend of remaining fixed in their places, move freely about, on on in the surface, but without the power of riving above or rinking below it, very much like shadows - only hard and with luminious edges - and you will then have a pretty correct notion of my country and countrymen. Alas, a 

### Summary

- 1. Tracking pedestrian trajectories in outdoor videos
- 2. Evaluation of the quality of an imaging system
- 3. Detection of roadside vegetation
- 4. Recognition of doors and steps
- 5. Counting objects (windows, roofs)
- 6. OCT image analysis
- 7. Sport highlights
- 8. Binary tomography
- 9. Microglia analysis using microscopy
- 10. Estimating roulette game outcome
- 11. Rubik's cube recognition and solution generation
- 12. Detecting (near) planar regions in stereo image pairs
- 13. Foamy events
- 14. Word puzzle recognition
- 15. Writer identification by handwriting

#### Now...

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

### Please ask questions