Project in Image Analysis, Study period 2, 2013

This document contains information about the project course in Image Analysis and suggestions for projects. **Deadline for registration** to the project course is **October 21, 2013**.

- Register to the course by sending e-mails both to the supervisors of the project (see list below) and to the coordinator Magnus Oskarsson (`magnuso@maths.lth.se`). Deadline for registration is **October 21, 2013**.
- Produce a short, but informative plan for your project work, about 1 page to all supervisors and to the coordinator. The plan should include a timeline of the work. Deadline is **November 1, 2013**.
- Project work according to plan. Contact your supervisors and decide on dates for supervision.
- Produce a written report (3-10 pages). Submit the report as a pdf file to all supervisors and the coordinator Deadline is **December 9, 2013**.
- Oral presentation and review of other project. Preliminary date is **December 11, 2013**.

The list of suggested projects is brief. For further information and for material contact the supervisors of the project.

1. **Classifications of Cells**
   This project involves working with a data set of 1400 microscopic images of cells. Each cell is in one of six possible stages in the cycle and the task is to construct a system for automatic classification of the stage. The project can be seen as a continuation of the OCR task of the image analysis course and will involve more advanced machine learning techniques and more advanced features.
   Contact: JU.

2. **Image analysis of jellyfish images for modelling of jellyfish**
   In an ongoing collaboration with the vision group at the department of Biology, we would like to model the visual processing and motor feedback of jellyfish. In this project the aim is to perform feature detection on image sequences of jellyfish to measure their motion, while controlling their visual input.
   Contact: KÅ, MO.

3. **Feature detection of hair-pin vortices**
   Modelling and understanding dynamical systems with chaotic characteristics is difficult because of their sensitivity to initial conditions and round-off errors. Some global characteristics, such as the size, duration and frequency of vortices, seem to be more stable. In this project the aim is to use feature detection to extract such characteristics from simulations in order to improve the modelling.
   Contact: KÅ, AS

4. **Bag-of-words**
   Bag of words is a popular technique within text understanding. Similar techniques have lately been tried to recognize objects in cluttered scenes. The goal of the project is to learn more about these techniques and to develop recognition algorithms based on such methods.
   Contact: JES, FJ.

5. **Tracking multiple objects using multiple cameras**
   To automatically explain what's going on in a scene by extracting trajectories of everyting moving in the scene is of interest in several cases. It can be used to assess traffic safety, study how people utilize public places, provide safety systems for industrial robots. We have several datasets which could be used in this project including a month recording from an intersection in Minsk from 6 cameras.
   Contact: HA, MN.

6. **Materialmätningar på asfalt**
   Matematikcentrum har ett projekt tillsammans med PEAB Asfalt i Helsingborg, där man är intresserad av materialegenskaper hos bl a asfalt och hur egenskaperna beror på t ex bitumens sammansättning, tillsatser, gruskornens storlek, form och fördelning. Målet med projektet är att utveckla automatiska metoder för att beräkna antingen gruskornens s k flisighet eller hur väl bitumen fästs på gruset.
   Contact: KÅ, HK.

7. **Tracking rats for neuroscience**
   The researchers at the Neuronano Research Centre need help tracking rats. Rats are being filmed from the side as they reach for a food pellet. The task is to automatically detect when the rats lift their paw from the floor. The basic idea will be to use foreground-background segmentation. (Their are other interesting tracking tasks as well.)
   Contact: TP.

8. **Object recognition**
   The goal of the project is to explore methods to detect objects in images, for instance a person, a motorbike or an animal like a dog or a cat. Detection would mean, in this case, placing a bounding-box around the object of interest. Existing methods operate by obtaining a classifier using a large training set of positive and negative examples (bounding boxes of objects of the desired type, as well any other objects or structures, not from that class). At test time, the classifier is run exhaustively at different locations and scales in the image, and a bounding box is reported at the location and scale where this fires. The technology works well for some objects (e.g. faces) but fails for many others, like people in general poses or animals. The goal of the project is to explore different, accurate methods for detection that would be applicable to a more diverse set of object categories. The project is best suited to highly motivated students with a strong mathematical background and excellent programming skills.
   Contact: CS.

9. **Medical Image Analysis**
   In the SCAPIS (Swedish CArdioPulmonary bioImage Study) project (www.scapis.se), the aim is to collect image data (CT, MRI and ultrasound) for 30.000 human subjects for studying heart and lung diseases. It will be the world's largest image database for this purpose. The need for automated analysis is immense. In this mini-project you will extend the heart segmentation in Handin 3 and work with data from the SCAPIS project.
   Contact: JU.

10. **Analysis of swimming based on digital image analysis**
    In a newly started company we are developing image analysis algorithm for tracking and analyzing professional swimmers. The proposed project consists of investigating different methods for tracking swimmers in multiple images or counting the number of strokes.
    Contact: AH, EA.

11. **Registration of medical images**
    The goal of this project is to test and implement methods for registration of medical images, i.e. estimating the transformation between two images or between an image and a model scene. The transformation could e.g. be a rigid transformation or a projective transformation. Using features such as SIFT and robust matching algorithms such as RANSAC robust and accurate registration can be achieved.
    Contact: NCO.

12. **Stereo from panoramas**
    Using two (spherical) panoramas taken with a baseline displacement it is possible to recover depth all around. In this project you will work on recovering 3D from such panorama pairs.
    Contact: JES.

13. **Eulerian video magnification**
    Recent research in amplifying small variations in video have shown that you can measure and amplify differences from tiny variations in video frames. From this you can record things like pulse, breathing etc. In this project you will use available source code to build an Eulerian magnification for a problem of your choice. (url: `http://people.csail.mit.edu/mrub/vidmag/`)
    Contact: JES.

14. **Image retrieval and SIFT**
    One of the most popular descriptors for image patches is SIFT. By storing a (large) collections of SIFT features and the corresponding images in a database, one obtains a simple, yet powerful image retrieval system (IMAGE GOOGLE). At runtime, the retrieval system works as follows. For an input (or query) image, SIFT feature vectors are first extracted and then, for each such feature vector, the closest SIFT vector is retrieved from the database. Database images with many similar SIFT features in common with the input image are given as output. The main problem is that each SIFT vector has dimension 128, and one needs a quick way of retrieving the nearest vector for each query vector. The aim of this project is to study such techniques for fast querying and to do an implementation. Other components like SIFT feature extraction is already available.
    Contact: JES, FJ.

15. **Detection of traffic congestion**
    The centre for mathematical sciences and the division of road and traffic technology are working together on algorithms for automatic analysis of road user behavior. One interesting sub-problem is to automatically detect traffic congestion from images. We have access to numerous images taken from cameras owned by the road and traffic authority.
    Contact: HA, MN.

16. **Background/foreground-segmentation**
    Stationary cameras that are observing objects moving against a more or less stationary background can be detected by so called background foreground segmentation algorithms. The goal of the project is to develop such techniques and evaluate them.
    Contact: MN, HA.

17. **Identification of digital pen writer.**
    In some applications it is interesting to determine which person that is using a digital pen. The input from the digital pen to the computer consists of a series of points with coordinates. In this application it is not necessary to recognize what is written, the focus is on who that is writing. The goal of this project is to investigate different techniques for writer recognition and try them on sample data.
    Contact: AH.

18. **Tredimensionell rekonstruktion av tvådimensionell uppklippt sfärisk yta**
    På Biologiska institutionen studeras olika typer av nerver. Detta projekt handlar om nerver i urinblåsan. Den är i det närmaste sfärisk så för att få platta preparat klipper vi upp blåsan så. Uppgiften är att finna en lämplig metod, som från denna typ av bild, rekonstruera den ursprungliga urinblåsan i tre dimensioner.Projektet ingår i ett samarbete mellan matematiska och biologiska institutionen.
    Contact: SD, AH.

19. **Evaluation of skin images**
    There is a growing interest in telemedicine, e.g. making diagnoses or recommendations from images or other information sent in to a doctor and/or an automatic decision system remotely. In this project, the goal is to analyze skin images in order to evaluate the risk that birth marks are malignant and the risk of developing skin cancer. The project is based on a collaboration with the company Instant Advice.
    Contact: AH.

20. **Own suggestion**
    You are free to come with your own suggestions on projects. Contact the project coordinator and get your project approved.
    Contact: MO.

Contact persons (supervisors):

HA	Håkan Ardö, ardo@maths.lth.se
EA	Erik Ask, erikask@maths.lth.se
SD	Stefan Diehl, diehl@maths.lth.se
AH	Anders Heyden, heyden@maths.lth.se
FJ	Fangyuan Jiang, fangyuan@maths.lth.se
HK	Hanna Källén, hanna.kallen@math.lth.se
MN	Mikael Nilsson, mikael.nilsson@math.lth.se
CO	Carl Olsson, calle@maths.lth.se
MO	Magnus Oskarsson, magnuso@maths.lth.se
NCO	Niels Overgaard, nco@maths.lth.se
TP	Tobias Palmér, tobias.palmer@math.lth.se
JES	Jan Erik Solem, solem@maths.lth.se
AS	Alexandros Sopasakis, sopasak@maths.lth.se
CS	Cristian Sminchisescu, cristian.sminchisescu@math.lth.se
JU	Johannes Ulén ulen@maths.lth.se
KÅ	Kalle Åström, kalle@maths.lth..se