

International Summer School Computer Vision for Cultural Heritage 2007

August 20th - August 24th, 2007

Vienna University of Technology, Austria

Pattern Recognition and Image Processing Group (PRIP)



PROGRAM



**International Summer School
Computer Vision for Cultural Heritage 2007**

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Vienna University of Technology, Austria

Pattern Recognition & Image Processing Group
Institute of Computer Aided Automation
Vienna University of Technology
Favoritenstraße 9/183-2
A- 1040 Vienna, sec@prip.tuwien.ac.at

Martin Kampel & Robert Sablatnig

Vienna, August 17, 2007

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Breuckmann GmbH

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Co-Chairmen

<i>Martin Kampel</i>	<i>Vienna University of Technology</i>	<i>AT</i>
<i>Robert Sablatnig</i>	<i>Vienna University of Technology</i>	<i>AT</i>

Local Organization

<i>Sigrid Elsinger</i>	<i>Vienna University of Technology</i>	<i>AT</i>
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Lecturers

<i>Jean-Angelo (Angelo) Beraldin</i>	<i>Institute for Information Technology, National Research Council</i>	<i>CA</i>
<i>Martin Kampel</i>	<i>Vienna University of Technology</i>	<i>AT</i>
<i>Martin Lettner</i>	<i>Vienna University of Technology</i>	<i>AT</i>
<i>Hubert Mara</i>	<i>PIN - Servizi Didattici e Scientifici per l'Università di Firenze</i>	<i>IT</i>
<i>Andreas Müller</i>	<i>Vienna University of Technology</i>	<i>AT</i>
<i>Tomas Pajdla</i>	<i>Center for Machine Perception, Czech Technical University</i>	<i>CZ</i>
<i>Robert Sablatnig</i>	<i>Vienna University of Technology</i>	<i>AT</i>
<i>Martin Sauerbier</i>	<i>Institute of Geodesy and Photogrammetry, ETH- Hoenggerberg</i>	<i>CH</i>

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Participants

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Timetable

	Monday August 20th 2007	Tuesday August 21st 2007	Wednesday August 22nd 2007	Thursday August 23rd 2007	Friday August 24th 2007		
09:00	Opening, Administration, Introductions	Lecture 3: Martin Sauerbier	Lecture 4: Tomas Pajdla	Practical Course 5	Presentations 1		
09:30				Coffee Break		Coffee Break	Coffee Break
10:00							
10:30	Lecture 1: Jean-Angelo Beraldin	Lecture 3 cont.: Martin Sauerbier	Lecture 4 cont.: Tomas Pajdla	Practical Course 7	Presentations 2		
11:00	Coffee Break					Lecture 5: Bernd Breuckmann	
11:30	Lecture 1 cont.: Jean-Angelo Beraldin						Organization
12:00					Closing		
12:30	Lunch	Lunch	Lunch	Lunch			
13:00							
13:30							
14:00	Lecture 1 cont.: Jean-Angelo Beraldin	Practical Course 1	Practical Course 3	Practical Course 8			
14:30							
15:00							
15:30							
16:00	Coffee Break		Coffee Break	Coffee Break			
16:30	Lecture 2: Martin Lettner	Coffee Break	Practical Course 4	Practical Course 9			
17:00		Practical Course 2					
17:30							
18:00							
18:30							
19:00		Dinner					
19:30	Dinner		Dinner	Dinner			

Monday, August 20th 2007

09:00 **Opening, Administration, Introductions**

Location: *Seminar Room 186*,
Favoritenstraße 9-11, 1040 Wien, stair 1 (labelled "Stiege I"), 5th floor, yellow area

10:15 **Lecture 1**

Jean-Angelo Beraldin

"Three-dimensional Sensing and Modelling: Theory and Applications aimed at the Cultural Heritage sector"

The lecture presents an introduction to the latest active 3D sensing and some photogrammetric techniques found in the literature and in commercial products. For each type of 3D method, hardware and software related topics are presented. Basic knowledge of 3D measurement principles, Gaussian beam propagation and optical signal detection is provided so that critical aspects like image resolution and range image precision can be evaluated. Furthermore, algorithms related to polychromatic reflectance estimation, control of scanning mechanisms and, calibration are presented.

Among the applications presented, some were demonstrated by NRC researchers and others by our collaborators. In particular, it is shown that 3D sensing is a powerful documentation tool that can complement other traditional methods. The last decade has seen an increased number of publications related to systems that combine laser scanning and close-range photogrammetry technologies in order to address the challenges posed by application fields as diverse as industrial, automotive, space exploration and cultural heritage to name a few. The need to integrate those technologies is driven by resolution, accuracy, speed and operational requirements, which can be optimized using general techniques developed in the area of multi-sensor and information fusion theory. The examples presented here address an aspect critical to multi-sensor and information fusion, i.e., the estimation of systems uncertainties. The understanding of the basic theory and best practices associated to laser range scanners, digital photogrammetry, processing, modelling are in fact fundamental to fulfilling the requirements listed above in an optimal way. In particular, two categories of applications are covered, i.e., information augmentation and uncertainty management. Results from both space exploration and cultural heritage applications are shown.

11:00 **Coffee Break**

11:15 **Lecture 1 continued**

12:30 **Lunch**

Vouchers (EUR 5.50) for *Mensa/Schrödinger* are available.

14:00 **Lecture 1 continued**

16:00 **Coffee Break**

16:30 **Lecture 2**

Martin Lettner

„Multispectral Imaging for Cultural Heritage Applications“

Multispectral imaging for cultural heritage applications provides additional information when investigating e.g. paintings, drawings or old manuscripts. Therefore the image

acquisition includes an extended electromagnetic spectrum ranging from ultraviolet to the infrared range. Moreover methods based on digital image analysis are used to extract information which the human eye cannot see. The talk presents physical background for multispectral imaging, presents multispectral image acquisition systems, and shows some recent applications, including the investigation of manuscripts and paintings.

19:30 **Dinner @ Siebenstern Bräu**

Tuesday, August 21st 2007

09:00 **Lecture 3**

Martin Sauerbier

"Photogrammetric 3D documentation and modelling of medium and large scale cultural heritage sites"

In recent years, in the Cultural Heritage related community the use of spatial information increased strongly. Especially for medium and large size objects and sites, Geographical Information Systems (GIS) are deployed for data management and archaeological analysis at a regional scale. An important prerequisite for such analyses is the availability of accurate spatial data which can serve as a basis for further investigations. Photogrammetry, as an image-based 3D measurement technology, provides a valuable range of products which can be derived efficiently from aerial and spaceborne imagery, i.e. Digital Terrain Models (DTM), Orthoimages and 3D vector data.

Beginning with an overview of sensor platforms, satellite and analogue and digital aerial sensors and image providers, a brief introduction to sensor modeling for frame cameras and linear array CCD sensors will be given. Furthermore, image orientation will be discussed while the focus will be laid on the generation of the aforementioned photogrammetric products. Here, the recent developments in terms of automation for DTM generation, the generation of orthoimages and automated as well as semi-automated approaches for the 3D extraction of objects will be described. To conclude the photogrammetric processing workflow, some visualization aspects concerning large datasets will be addressed. Finally, an overview of recent trends in photogrammetric research and future possibilities will be given.

The mentioned processing steps will be demonstrated by means of various Cultural Heritage projects conducted in our group, i.e. the 3D reconstruction of the Great Buddha of Bamiyan (Afghanistan), the Nasca/Palpa and the reconstruction of adobe architecture at Túcume projects (Peru), the 3D modeling of the pre-Columbian settlement of Xochicalco (Mexico), the 3D reconstruction of a Buddhist temple at Angkor (Cambodia) and further examples.

10:30 **Coffee Break**

10:45 **Lecture 3 continued**

12:00 **Organization**

For the **Practical Courses** you work in six groups with 5 students per group.

	Main Focus on:
Group 1 and 2	Minolta
Group 3 and 4	Riegl

Group 5 Breuckmann
Group 6 Hamamatsu

Although each group has its main focus you will see and have the chance to work with all equipment available!

The sites for **Practical Courses** are:

- “Station Minolta”: **Lecturer: Andreas Müller**

Seminar Room 183/2, stair 1 (labelled „Stiege I“), 4th floor, yellow area

At this station you work with the Minolta VIVID 9i. It is a close range laser range finder which is mainly used for quality assurance (inspection of surfaces), industrial design (reverse engineering), research, animation and virtual reality (game design), architecture, archaeological restorations, virtual museums etc.

You learn how to acquire 3d data, clean the data from distortions arised during the acquisition process, register surfaces and merge them to get a complete 3d model of the scanned object. As an example for a cultural heritage application you see how it could be helpful to have a 3d model of a vase or a sherd to extract a profile line and measure objects with high accuracy.

- “Station Hamamatsu”: **Lecturer: Martin Lettner**

Multimedia Lab (HA0420), stair 1 (labelled „Stiege I“), 4th floor, yellow area

This station shows multispectral imaging in the field of cultural heritage including different acquisition systems, e.g. high resolution cameras (Hamamatsu C9300, Nikon) or conventional cameras (Sony). The experiments show the considerable advantages of multispectral imaging when investigating paintings or manuscripts.

The lab exercises include the acquisition of real paintings and test data and some small computer exercises based on digital image analysis.

- “Station Breuckmann”: **Lecturer: Bernd Breuckmann**

Library, stair 2 (labelled “Stiege II”), 4th floor, purple area

- “Station Riegl”: **Lecturer: Hubert Mara**

Mozartplatz near Favoritenstraße 9

At the outdoor station (Mozartplatz) we use a Riegl scanner for acquisition of larger objects, like facades of buildings, memorials including parts of landscapes surrounding objects of interest. It not only shows the contrast of acquisition of relatively small objects with Minolta and Breuckmann, this practical exercise also demonstrates another technology for 3D-acquisition.

- Personal Computers to work with:

Prip Lab: stair 1 (labelled „Stiege I“), 4th floor, yellow area

12:30

Lunch

Mensa/Schrödinger.

- 14:00 **Practical Course 1**
 Showcase: Each group gets a hardware demonstration at each station during Practical Course 1 and 2.
- 14:00 Groups 1 and 2 Showcase at “Station Minolta”
 Groups 3 and 4 Showcase at “Station Riegl”
 Groups 5 and 6 Showcase at “Station Hamamatsu”
- 15:15 Groups 5 and 6 Showcase at “Station Minolta”
 Groups 1 and 2 Showcase at “Station Riegl”
 Groups 3 and 4 Showcase at “Station Hamamatsu”
- 16:30 **Coffee Break**
- 17:00 **Practical Course 2**
- 17:00 Groups 3 and 4 Showcase at “Station Minolta”
 Groups 5 and 6 Showcase at “Station Riegl”
 Groups 1 and 2 Showcase at “Station Hamamatsu”
 End: 18:15
- 19:00 **Dinner @ Schweizerhaus**

Wednesday, August 22nd 2007

- 09:00 **Lecture 4**
Tomas Pajdla
 “3D Reconstruction from Photographs - Towards a Digital Langweil Model of Prague”
 I will present principles of 3D reconstruction from photographs and demonstrate some of the techniques on examples from the ongoing reconstruction of the Langweil historical model of Prague. Firstly, I will explain how the model has been photographed to capture it in high level of detail. Secondly, I will explain principles of 3D reconstruction from photographs and will demonstrate them on reconstructing manually a small part of the model. Finally, I will explain how to move towards more automatic reconstruction from very large number of photographs. I will explain principles of automated image matching, camera reconstruction, 3D dense stereo matching and deformable texture mapping.
- 10:30 **Coffee Break**
- 10:45 **Lecture 4 continued**
- 11:30 **Lecture 5**
Bernd Breuckmann
 “Fundamentals and applications of 3D measurement and digitization methods”
 Breuckmann has been playing a key role in developing and optimising topometric 3D metrologies for more than two decades. With more than 300 systems installed per year,

Breuckmann 3D scanners are among the most powerful and successful systems in the world of image-forming 3D metrology.

We offer products within three major application fields:

HighEnd industrial applications, In-vivo digitisation of the human body, Arts and cultural heritage.

- 12:30 **Lunch**
Mensa/Schrödinger.
- 14:00 **Practical Course 3**
Acquisition: During Practical Course 3 and 4 you have the chance to work with the hardware available. You take images with our cameras and use our range sensors to acquire 3D data.
- 14:00 Groups 1 and 2 Acquisition at “Station Breuckmann”
Groups 3 and 4 Acquisition at “Station Riegl”
Groups 5 and 6 Acquisition at “Station Hamamatsu”
- 15:00 Groups 3, 4 and 5 Acquisition at “Station Breuckmann”
Groups 1 and 2 Acquisition at “Station Minolta”
Group 6 Acquisition at “Station Hamamatsu”
- 16:00 **Coffee Break**
- 16:30 **Practical Course 4**
- 16:30 Groups 5 and 6 Acquisition at “Station Breuckmann”
Groups 1 and 2 Acquisition at “Station Minolta”
Groups 3 and 4 Acquisition at “Station Riegl”
- 17:30 Group 5 Acquisition at “Station Breuckmann”
Groups 1 and 2 Acquisition at “Station Minolta”
Groups 3 and 4 Acquisition at “Station Riegl”
Group 6 Acquisition at “Station Hamamatsu”
End: 18:30
- 19:30 **Dinner @ Heuriger**

Thursday, August 23rd 2007

- 09:00 **Lecture 6**
Short introduction into Raindrop Geomagic (processing 3D data), and Mathworks Matlab (processing multidimensional data).
- 09:30 **Practical Course 5**
Processing Data: work with the 2D and 3D data acquired the days before.
- 10:30 **Coffee Break**
- 10:45 **Practical Course 6**
Processing Data: work with the 2D and 3D data acquired the days before.
- 12:30 **Lunch**

Mensa/Schrödinger.

- 14:00 **Practical Course 7**
Prepare written document & presentation:
Time to prepare your written documents and the presentation on the Personal Computers located at *PRIP Lab*.
- 16:00 **Coffee Break**
- 16:30 **Practical Course 8**
Prepare written document & presentation:
Time to prepare documents and the presentation on the Personal Computers located at *PRIP Lab*.
End: 18:30
- 19:30 **Dinner @ N.N.**

Friday, August 24th 2007

- 09:00 **Presentations 1**
Each group (1 to 3) has 30 minutes to present their achieved results.
- 10:30 **Coffee Break**
- 10:45 **Presentations 2**
Each group (4 to 6) has 30 minutes to present their achieved results.
- 12:15 **Closing**
End: 13:00

Important Locations:

Venue:

Institute of Computer Aided Automation, Pattern Recognition & Image Processing Group
(Favoritenstraße 9-11, 1040 Wien),

Where to find us:

Take the subway U1 to the stop "Taubstummengasse". Use the exit "Taubstummengasse", walk along the "Favoritenstraße" in the direction "Karlsplatz" (same direction as the exit), pass the pharmacy until you reach the second of the big wooden gates. Then walk straight through the yard and enter the building through the door under the big clock (signed "Stiege 2"). Take the elevator (or the stairs) to the 4th floor. Leave the elevator, enter the floor through the glass door and make a left. You are standing in front of the office door. Please dial the number of your contact person on the wall-mounted telephone or ring the bell, enter the institute and go to the office (first door, right side).

Where you have **Lectures:**

Seminar Room 186, stair 1 (labelled "Stiege I"), 5th floor, yellow area

Where you have **Practical Courses:**

"Station Minolta":

Seminar Room 183/2, stair 1 (labelled „Stiege I“), 4th floor, yellow area

"Station Hamamatsu":

Multimedia Lab (HA0420), stair 1 (labelled „Stiege I“), 4th floor, yellow area

"Station Breuckmann":

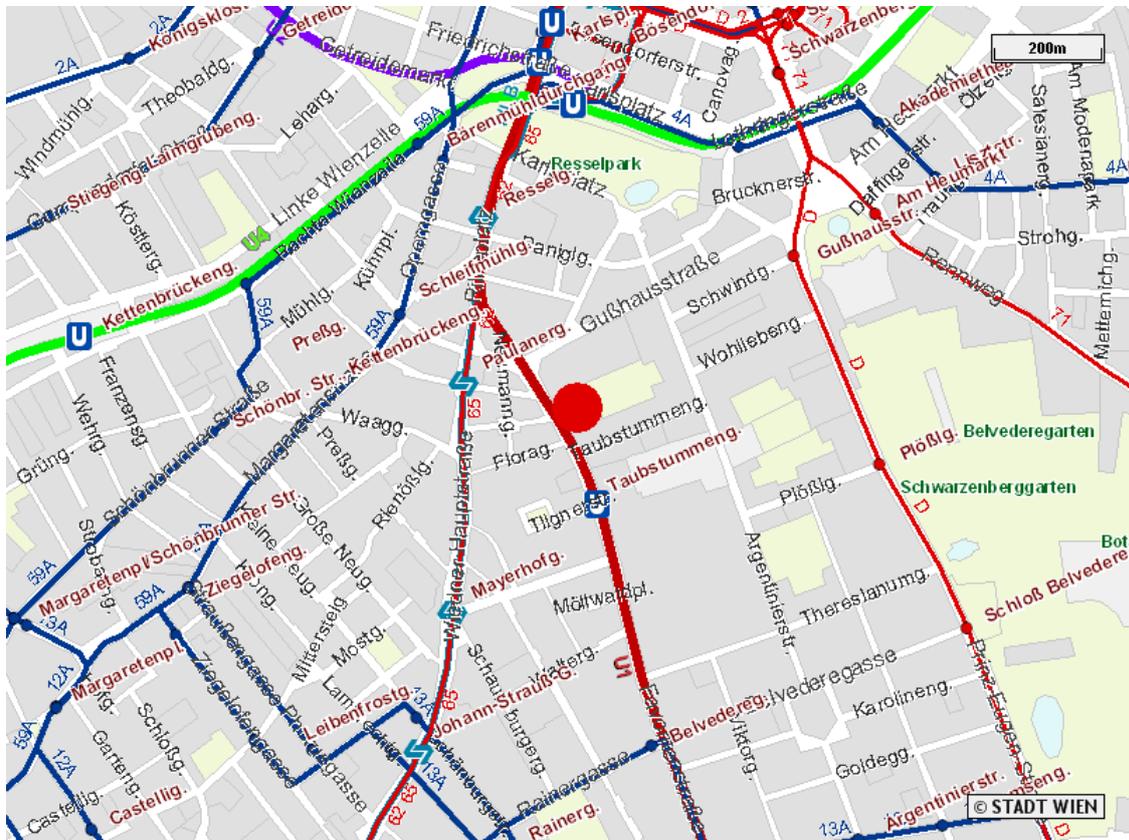
Library, stair 2 (labelled "Stiege II"), 4th floor, purple area

"Station Riegl":

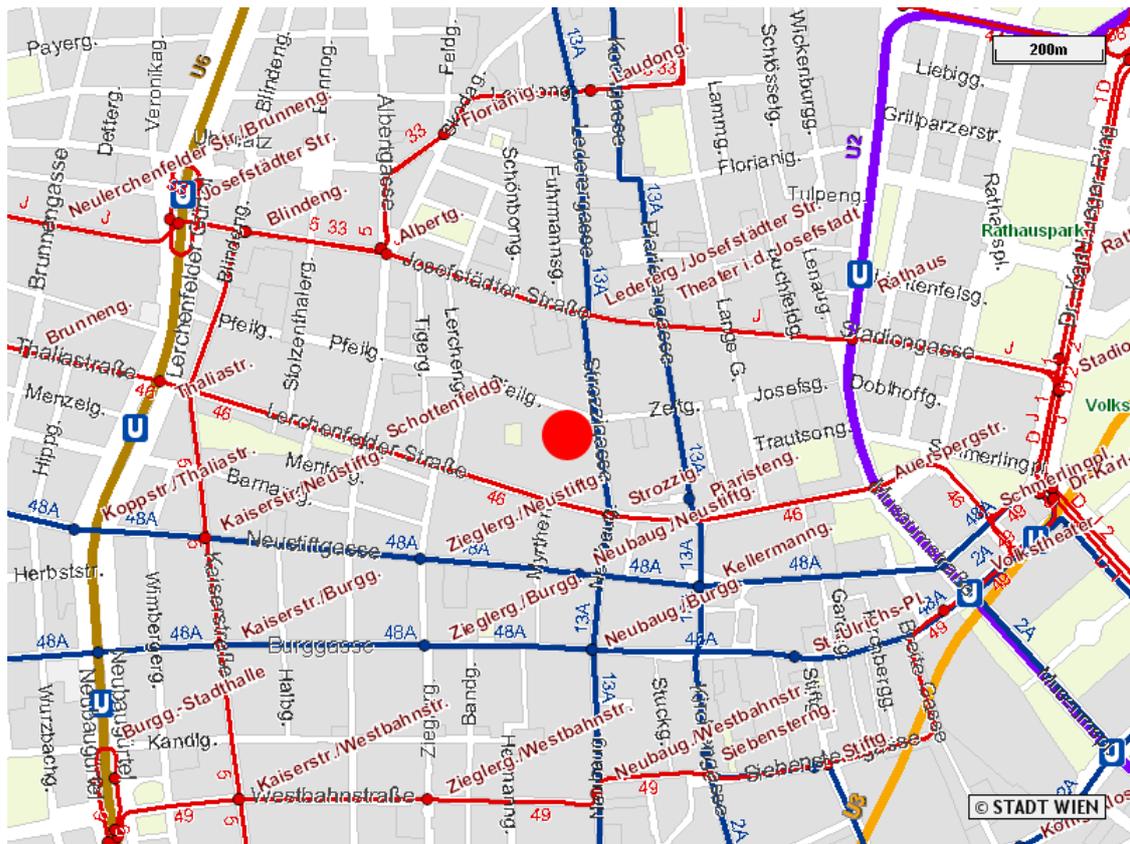
Somewhere outdoor near Favoritenstraße 9

Personal Computers:

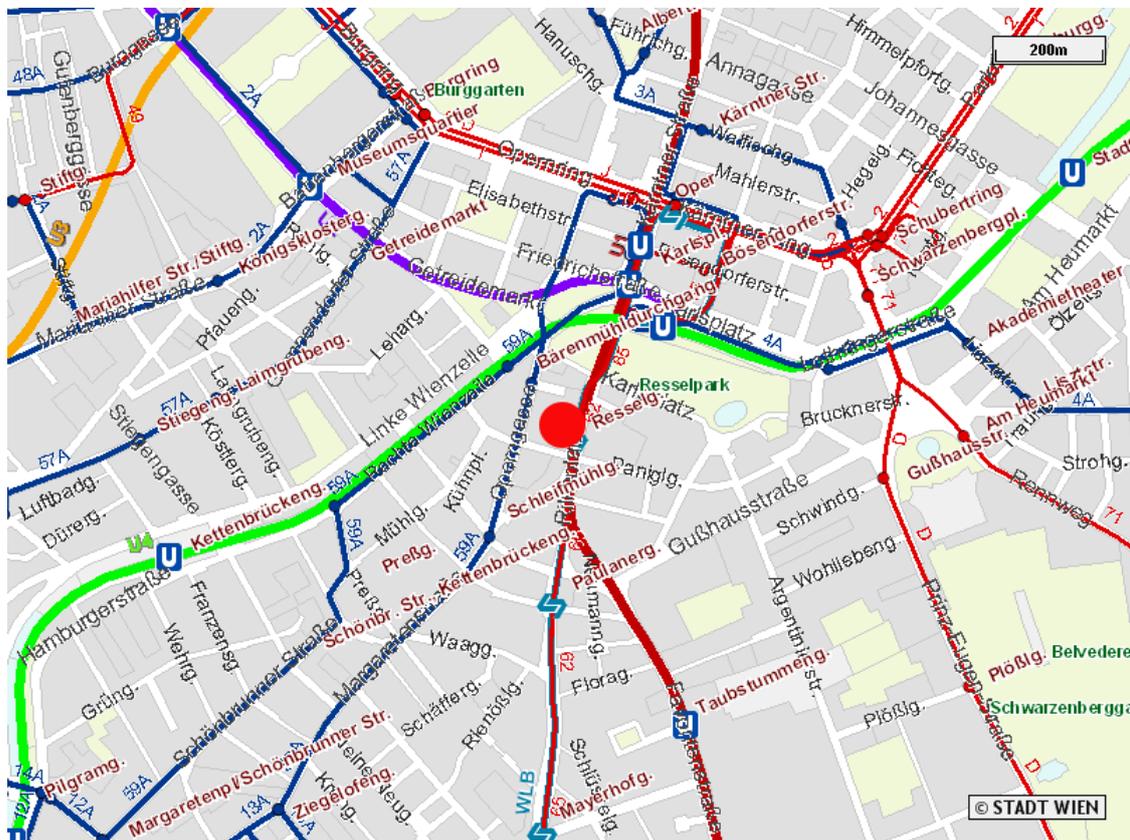
Prip Lab: stair 1 (labelled „Stiege I“), 4th floor, yellow area



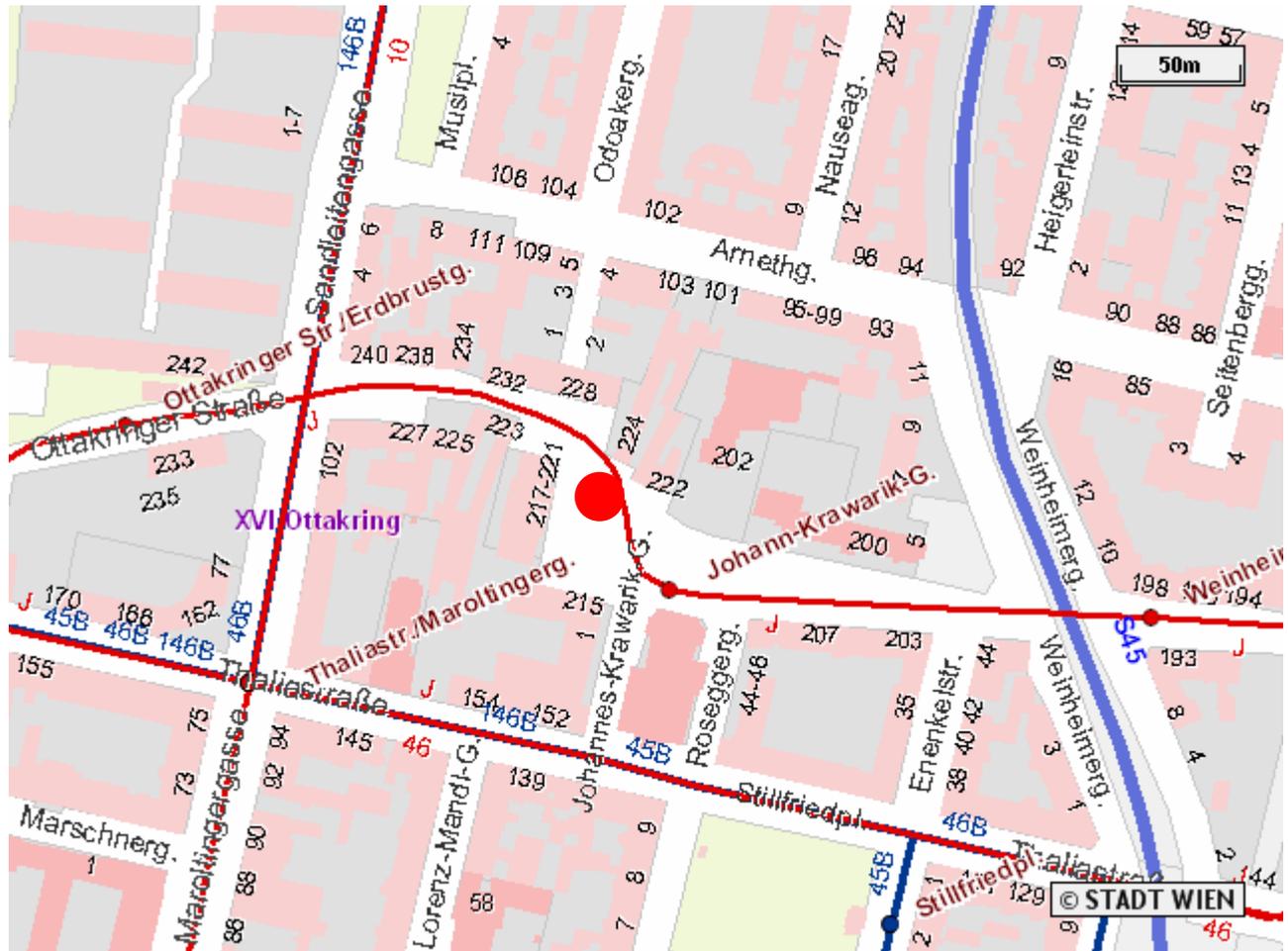
Your Accommodation:
Pfeilheim (Pfeilgasse 1-6, 1080 Wien)



Where you get Lunch:
Mensa/Schrödinger (Wiedner Hauptstraße 8-10, 1040 Wien)



Heuriger (10er Marie), Ottakringer Str. 222-224, A-1160 Wien, Wednesday, Aug. 22nd, 2007.



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