Computer Vision for Microscopes

Microsystem & Machine Vision Laboratory

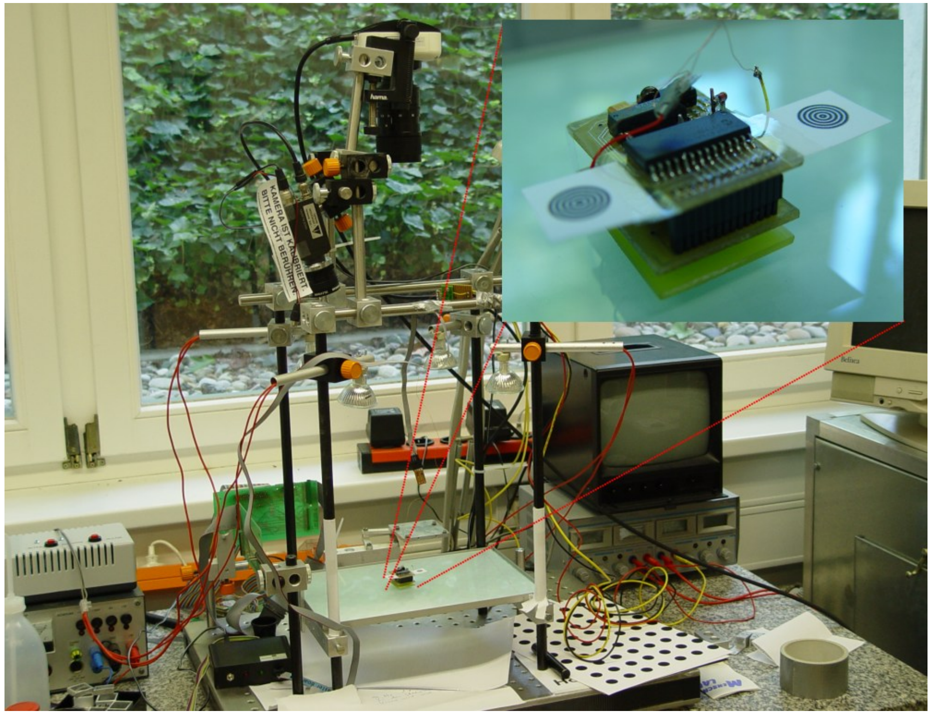
16th Dec 2005

MMVL	http://vision.eng.shu.ac.uk/mmvl/ (vision/www)
MRC	http://www.shu.ac.uk/research/meri/modelling_rc.html
MERI	http://www.shu.ac.uk/research/meri/
SHU	http://www.shu.ac.uk/

MiCRoN

European Union IST project

Uppsala, Lausanne, St. Ingbert, Athens, Pisa, Barcelona, Karlsruhe



project goals

- Manipulate μm-sized objects
- Closed-loop control of robots
- 3D object recognition and tracking

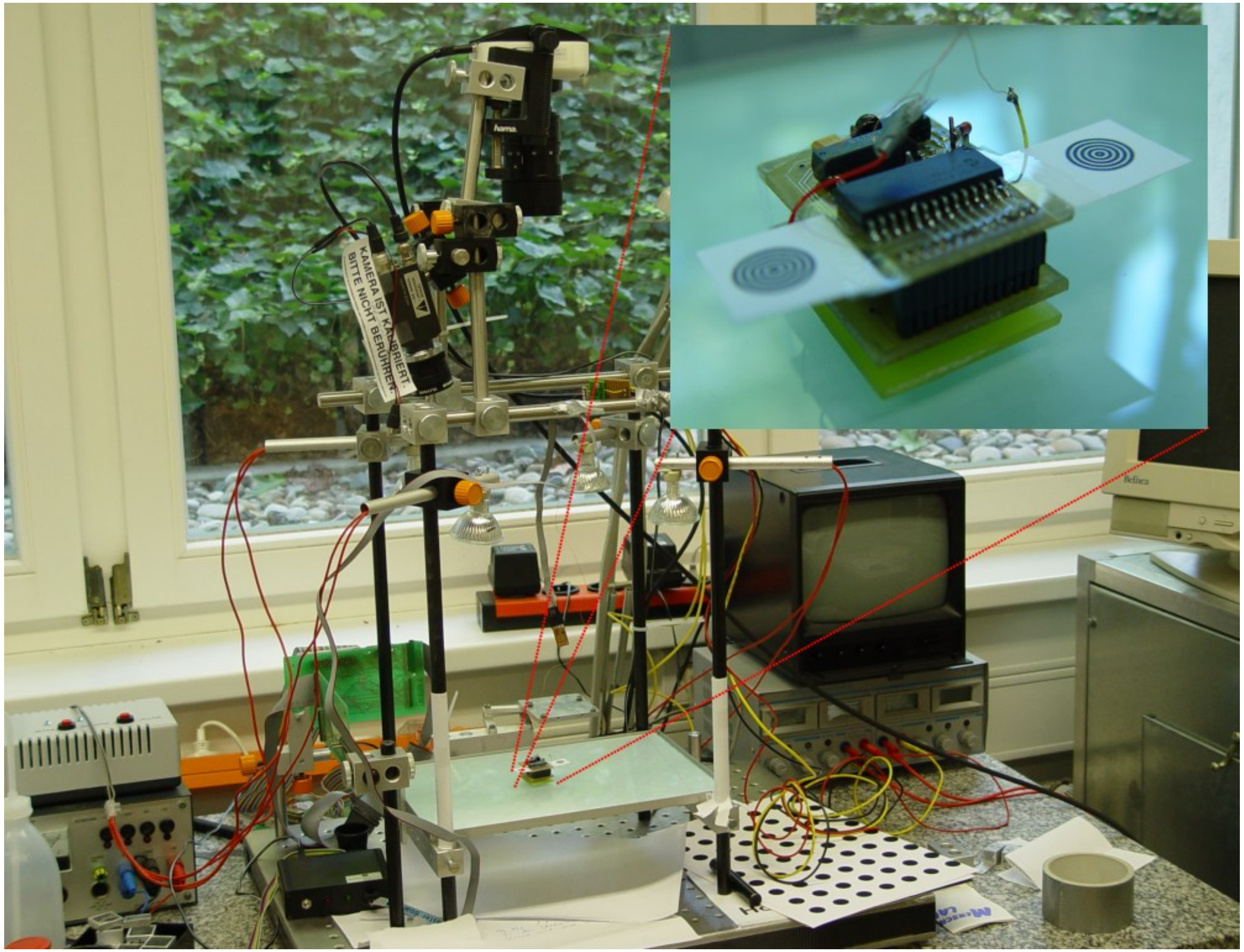
image acquisition

- micro-camera
- microscope

http://wwwipr.ira.uka.de/~micron/

http://www.cordis.lu/ist/

MiCRoN

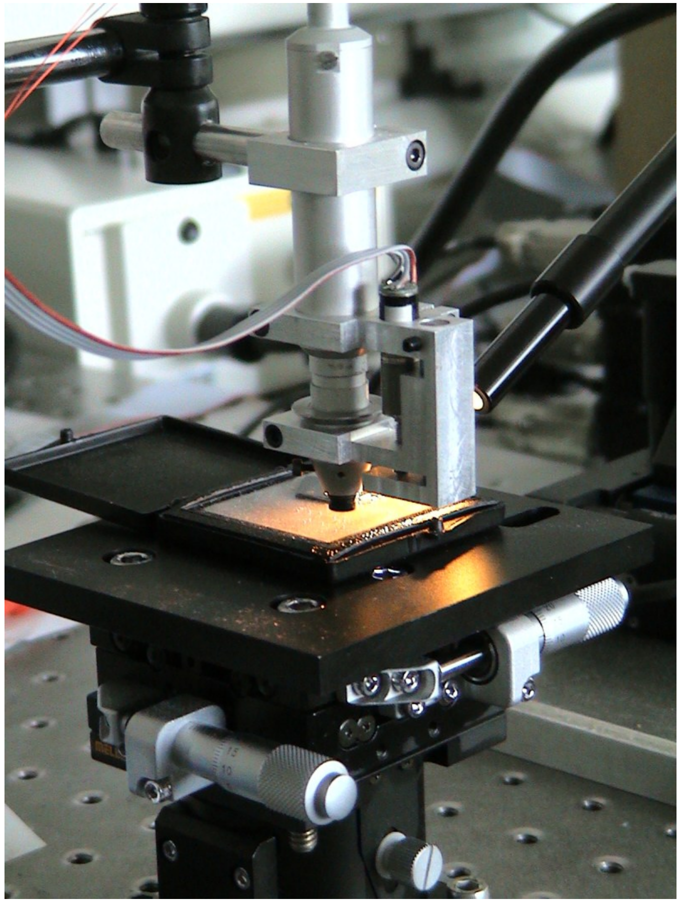


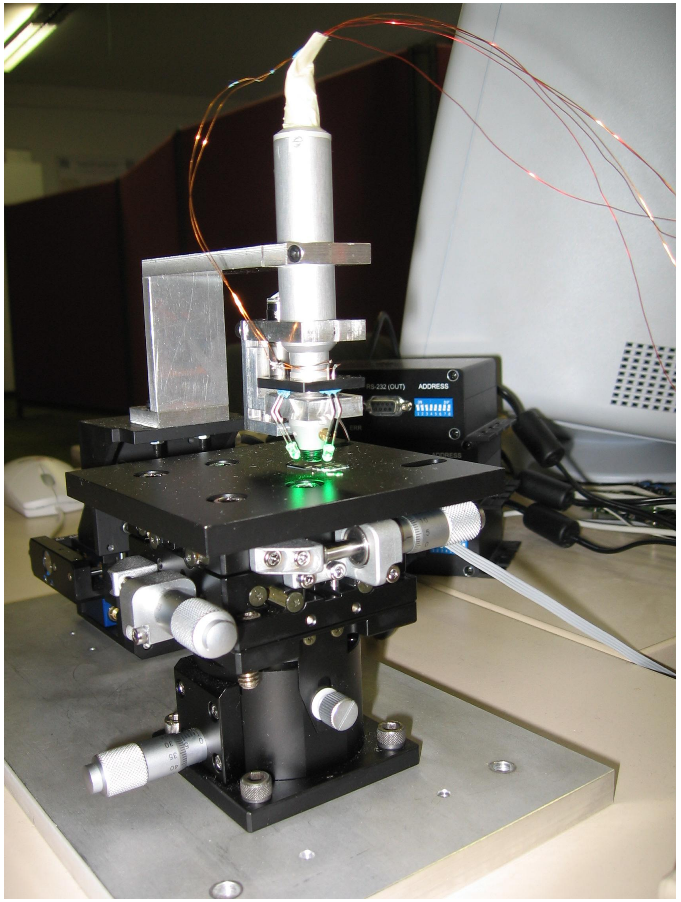
MiCRoN hardware (i)

camera

test hardware (i)

test environment





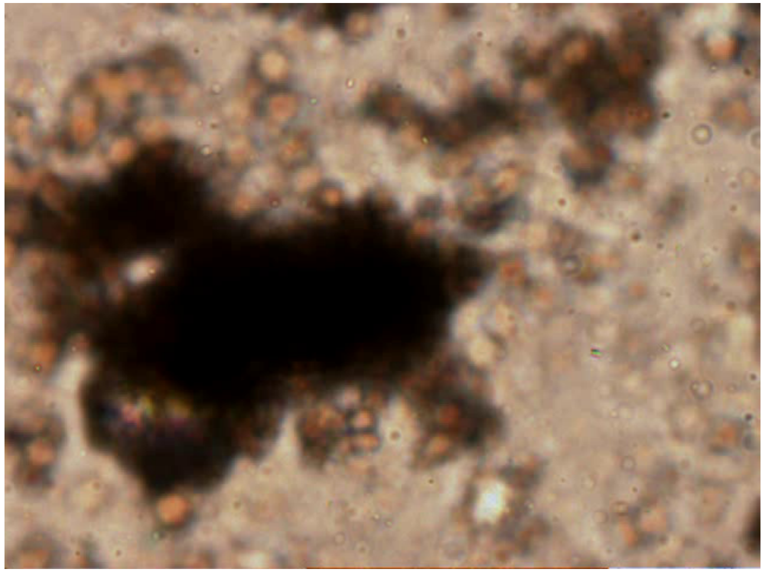
MiCRoN hardware (ii)

first pictures

video

test hardware (ii)

microscope environment


camera sensor


actors

software

Mimas computer vision toolkit
open source computer vision library

deliver solution ⇐ restrict vision domain
⇐ develop reusable toolset

- Sensor data: V4L, gstreamer-interface
- Segmentation: LSI-filters, morphology, disparity-estimator, DFT, image-processing
- Feature-extraction: edges, corners, ...
- Feature-matching: optic flow, SVD-correspondence, correlation, champfer matching, PGH, fast POL
- pose-estimation: particle filter, hough transform

`http://vision.eng.shu.ac.uk/mediawiki/index.php/Mimas`

Canny-like edge detector

video

edges

geometric hashing

1988, Lamdan & Wolfson

Geometric Hashing : A General and Efficient Model-Based Recognition Scheme

Yehezkel Lamdan and Haim J.Wolfson

Robotics Research Laboratory
Courant Inst. of Math., NYU
715 Broadway, 12'th floor,
New York, N.Y. 10003.

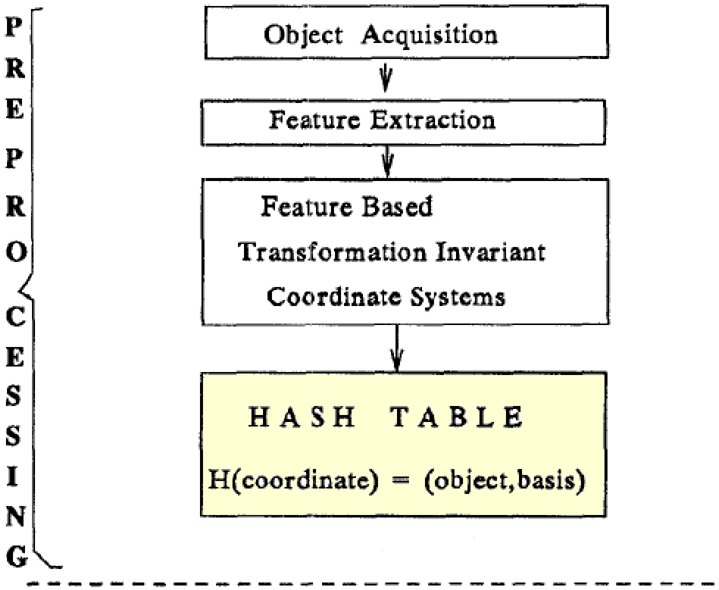
Abstract: A general method for model-based object recognition in occluded scenes is presented. It is based on *geometric hashing*. The method stands out for its efficiency. We describe the general framework of the method and illustrate its applications for various recognition problems both in 3-D and 2-D. Special attention is given to the recognition of 3-D objects in occluded scenes from 2-D gray scale images. New experimental results are included for this important case.

1. Introduction.

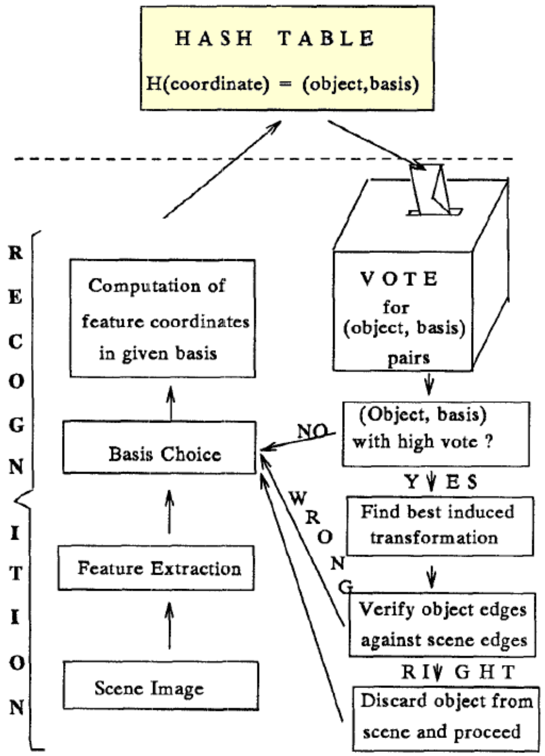
We present a unified approach to the *representation* and *matching* problems which applies to object recognition under various geometric transformations both in 2-D and 3-D. The objects are represented as sets of geometric features, such as points or lines, and their geometric relations are encoded using minimal sets of such features under the allowed object transformations. This is achieved by standard methods of *Analytic Geometry* invoking *coordinate frames* based on a minimal number of features, and representing other features by their coordinates in the appropriate frame. Our

geometric hashing

preprocessing

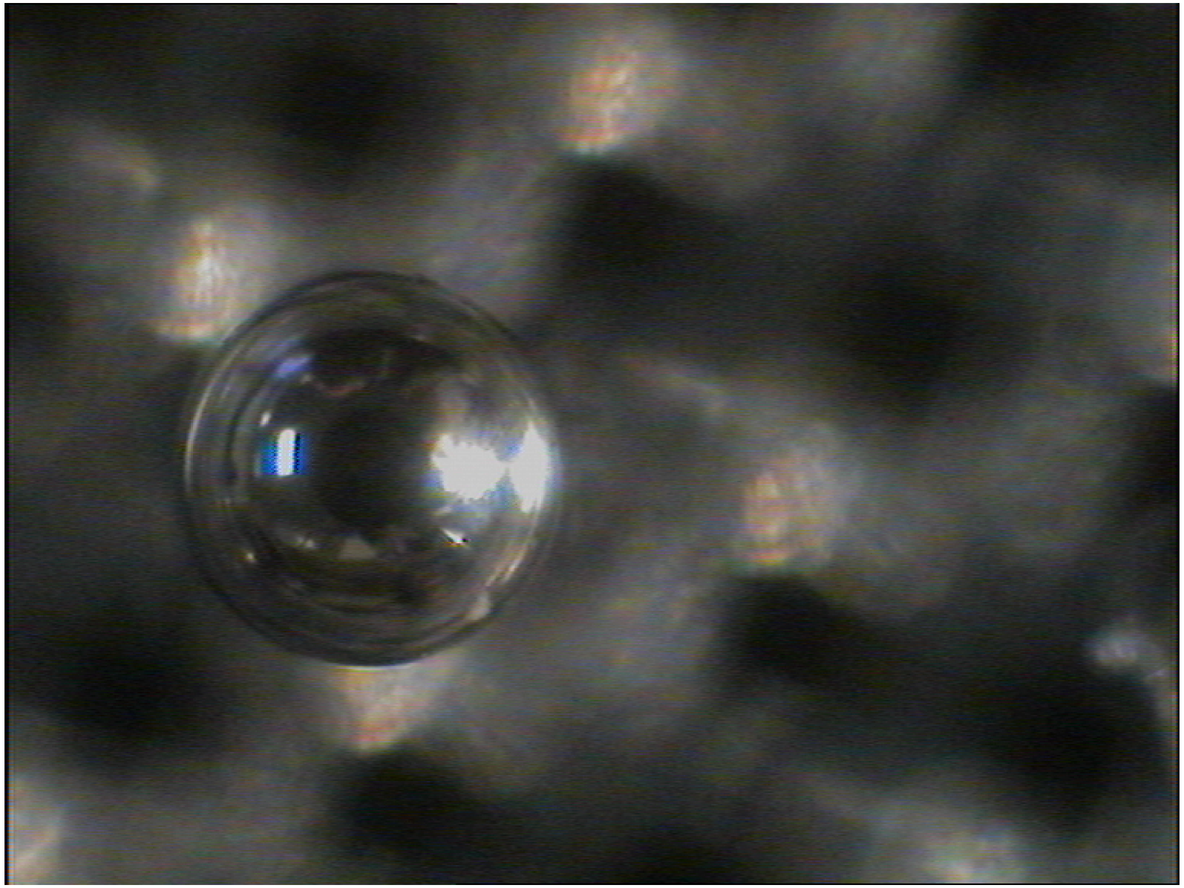


recognition



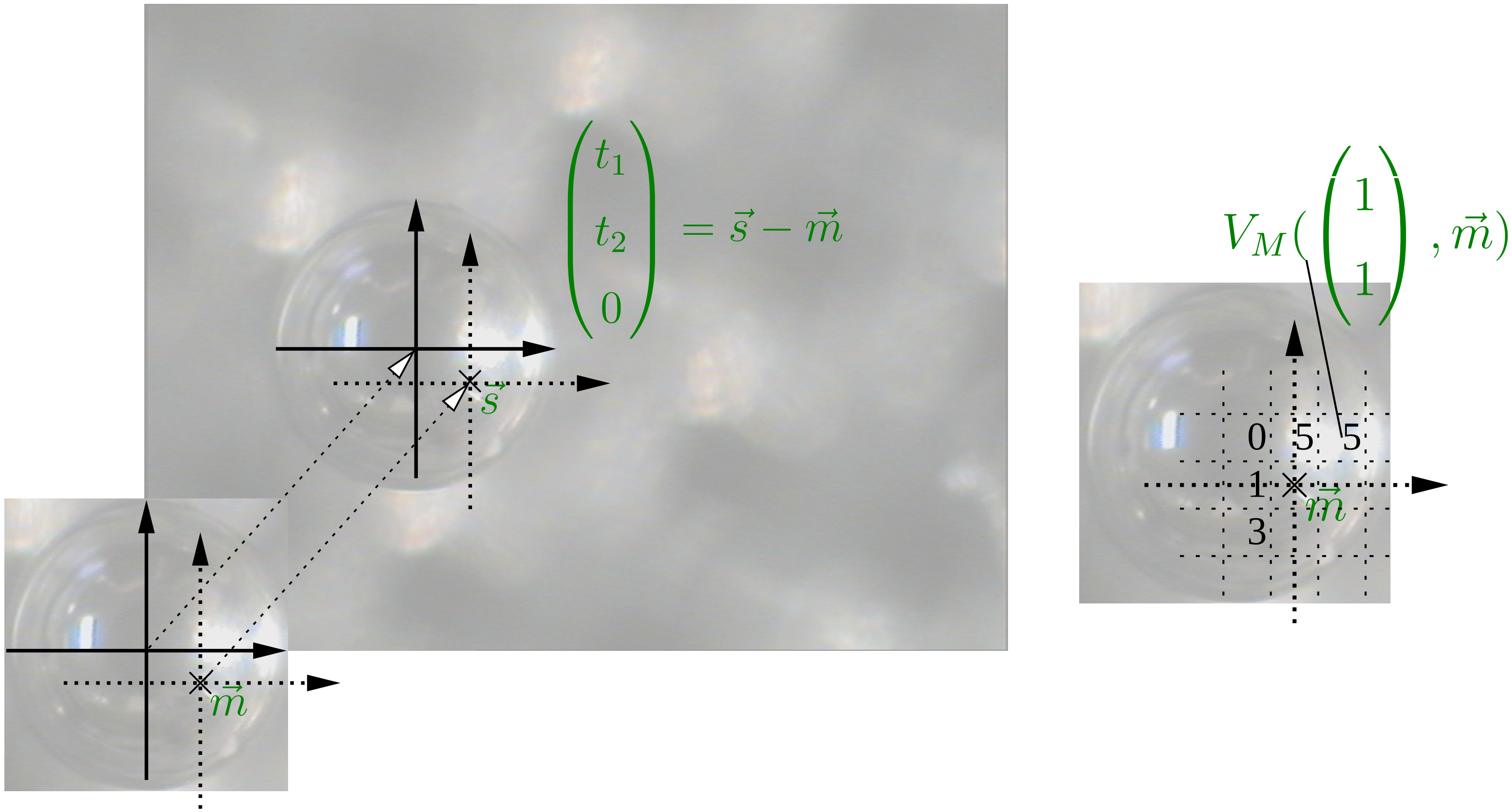
geometric hashing

2-D / 2 DOF



geometric hashing

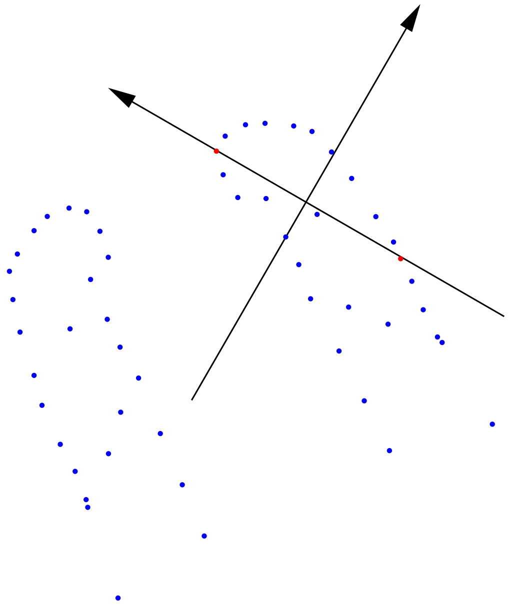
2-D / 2 DOF



geometric hashing

2-D / 3 DOF

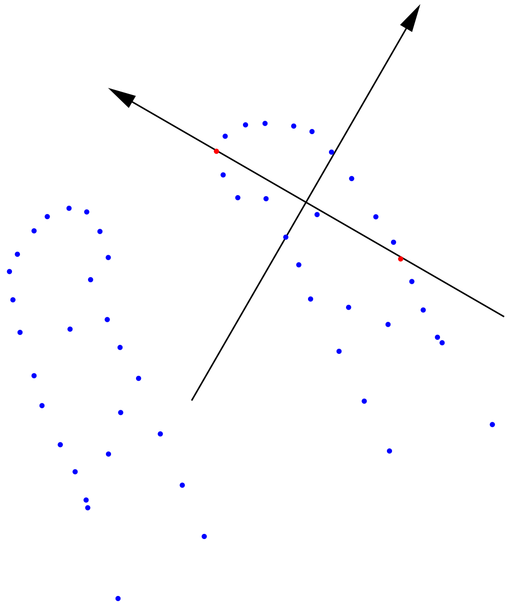
scene features



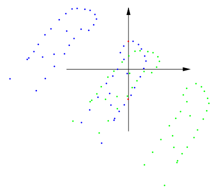
geometric hashing

2-D / 3 DOF

scene features



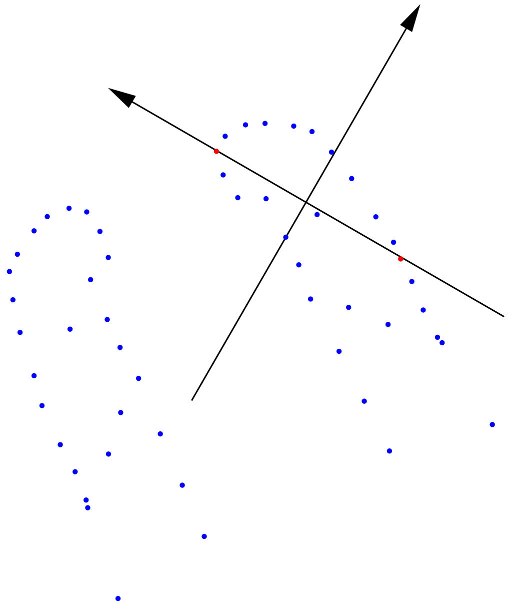
hash table

pose (3 DOF)				
hits	80			
misses	120			

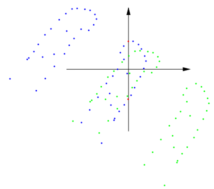
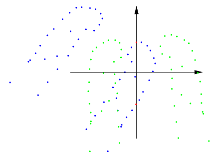
geometric hashing

2-D / 3 DOF

scene features



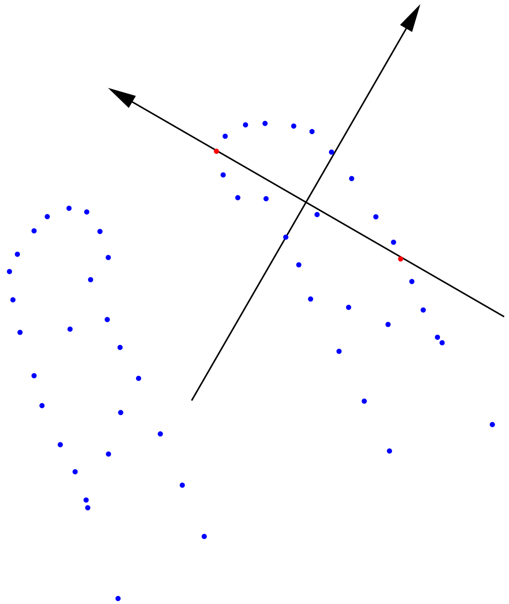
hash table

pose (3 DOF)				
hits	80	10		
misses	120	190		

geometric hashing

2-D / 3 DOF

scene features



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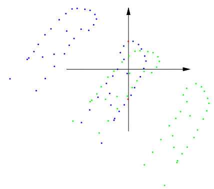
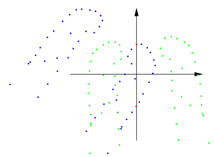
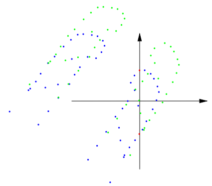
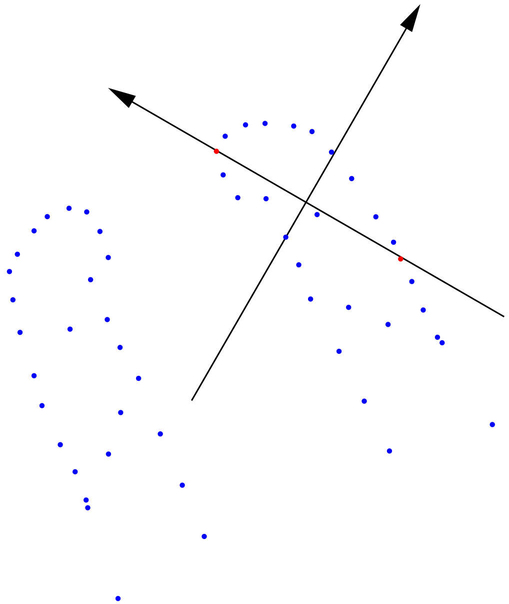
pose (3 DOF)				
hits	80	10	50	
misses	120	190	150	

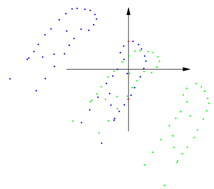
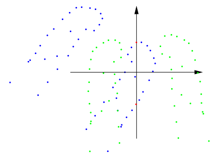
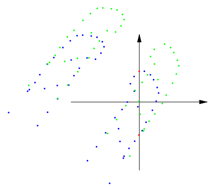
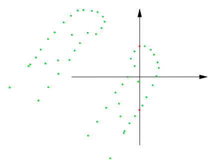
geometric hashing

2-D / 3 DOF

scene features

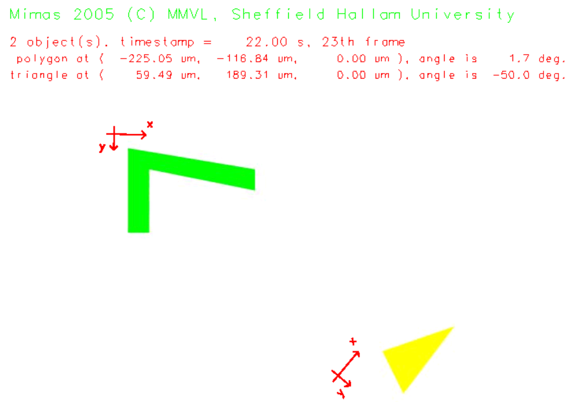


hash table

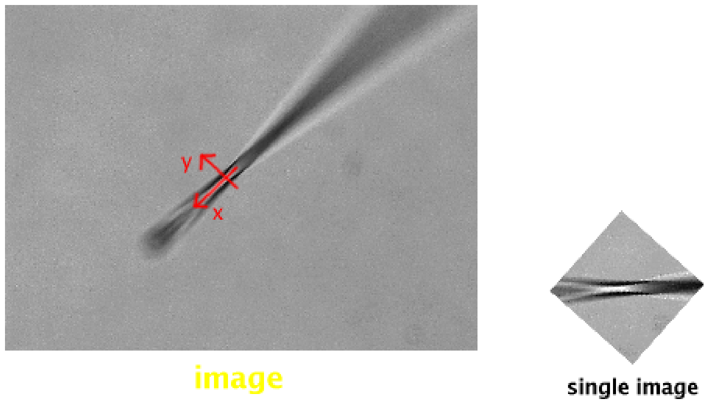
pose (3 DOF)				
hits	80	10	50	200*
misses	120	190	150	0*

geometric hashing

2-D / 3 DOF



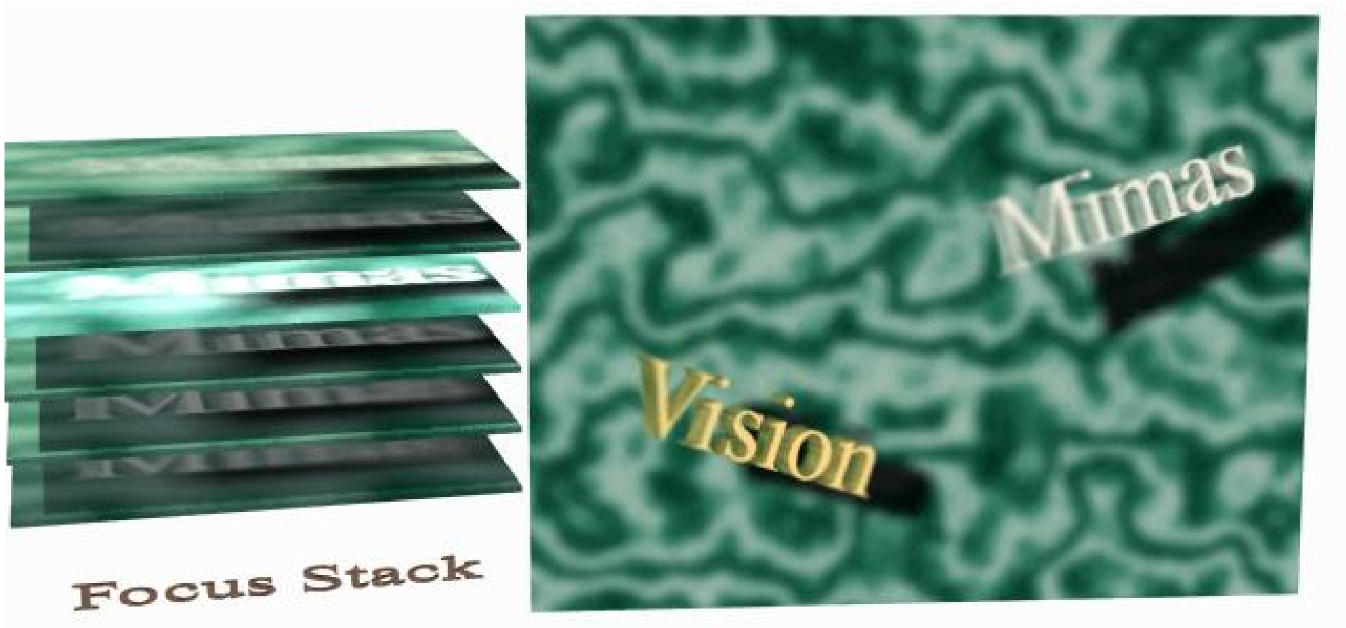
test on artificial sequence



test on pipette

geometric hashing

focus stacks as model database



geometric hashing

3-D/4 DOF

test on povray sequence (time lapse)

bounded hough transform

2001/2004, Greenspan, Shang & Jasiobedzki

Efficient Tracking with the Bounded Hough Transform

Michael Greenspan[1,2,4] Limin Shang[1] Piotr Jasiobedzki[3]

[1]Dept. of Electrical & Computer Engineering, [2]School of Computing, Queen's University, Canada
[3]MDRobotics, 9445 Airport Rd., Brampton, Ontario, Canada
[4]corresponding author: michael.greenspan@ece.queensu.ca

Abstract

The Bounded Hough Transform is introduced to track objects in a sequence of sparse range images. The method is based upon a variation of the General Hough Transform that exploits the coherence across image frames that results from the relationship between known bounds on the object's velocity and the sensor frame rate. It is extremely efficient, running in $O(N)$ for N range data points, and effectively trades off localization precision for runtime efficiency.

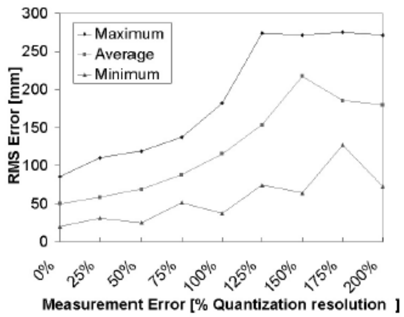
The method has been implemented and tested on a variety of objects, including freeform surfaces, using both simulated and real data from Lidar and stereovision sensors.

ing variants of the Iterative Closest Point Algorithm (ICP) [1]. This is primarily because range data is more expensive to collect, and so the images tend to be sparse, which makes it difficult to extract meaningful features. Examples of ICP-based tracking are [2, 3] and recently [4], which simultaneously reconstructs while tracking.

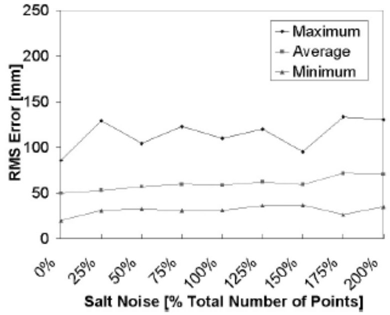
The Hough Transform is a well known and effective method of feature extraction and pose determination that has been explored thoroughly in the literature [5]. Many variations of the Hough Transform have been proposed [6], some of which are specifically tailored to tracking. The Velocity Hough Transform (*VHT*) [7] included a specific ve-

bounded hough transform

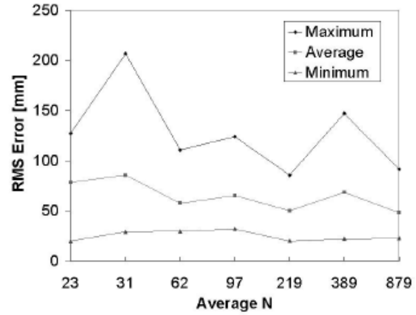
2001/2004, Greenspan, Shang & Jasiobedzki



a) measurement error



b) outliers



c) sparse data

Figure 6: Effects of Data Degradation

Figure 7: Robot Mounted Satellite Model

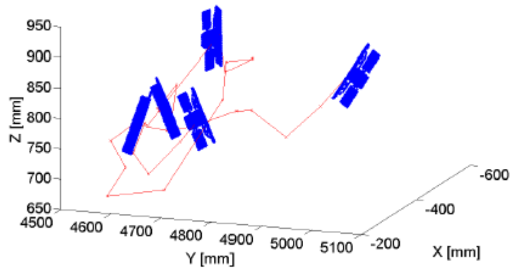


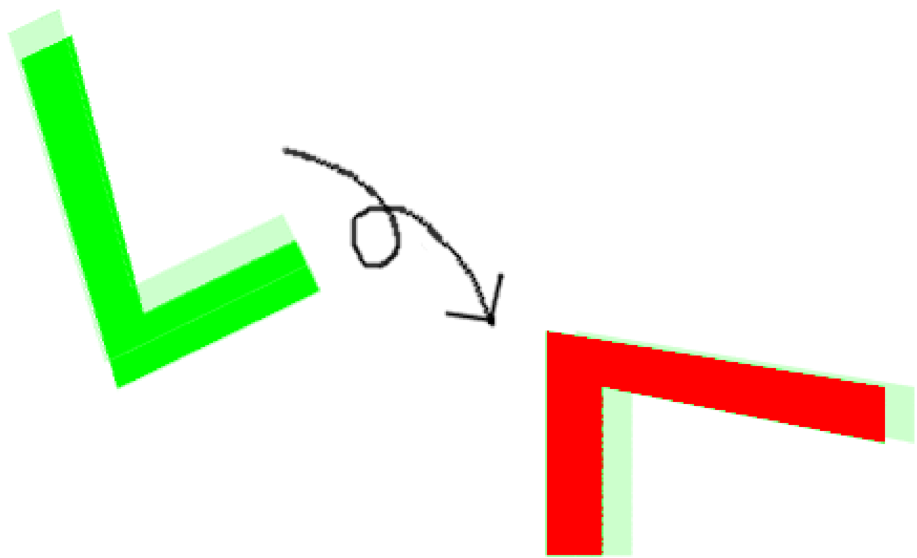
Figure 8: Satellite Trajectory, Lidar Data

of a Radarsat satellite was mounted on a 6 dof articulated

majority of which fell on the surface of the robot and the background and were therefore outliers. To demonstrate the effectiveness of the method at tracking in sparse as well as

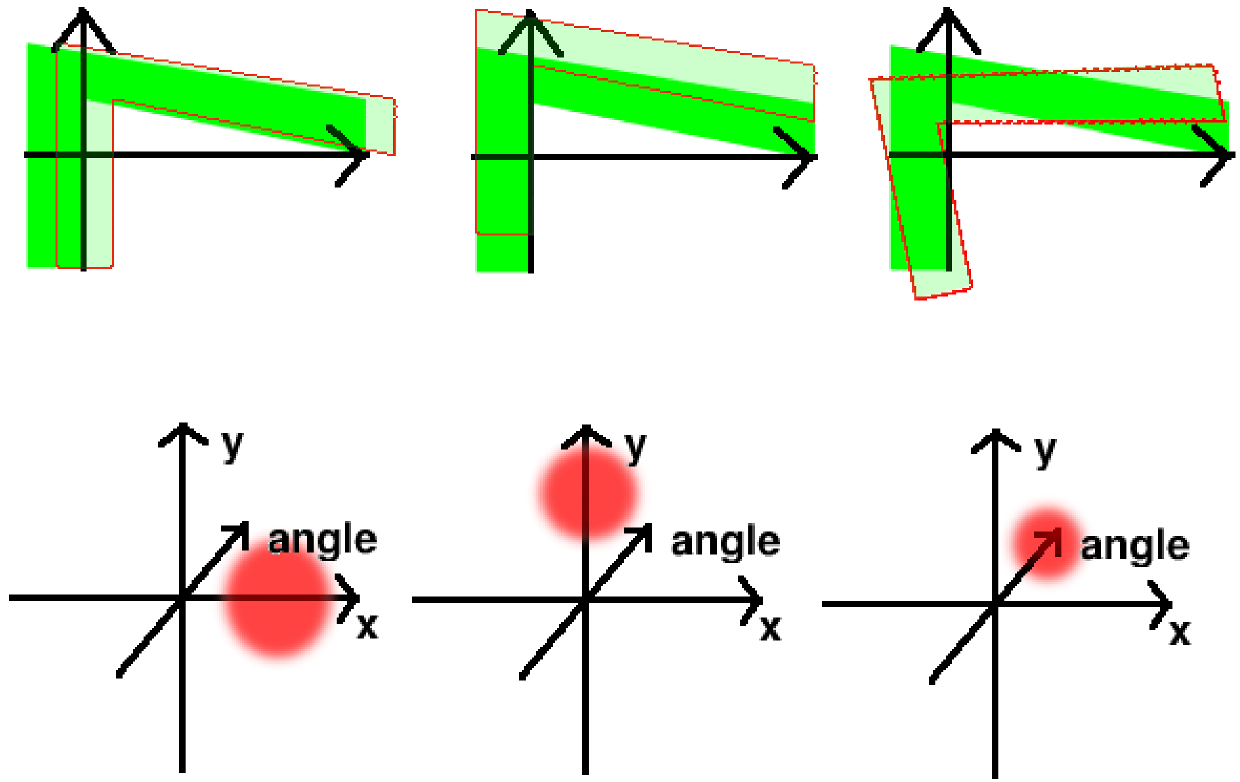
bounded hough transform

inverse transformation



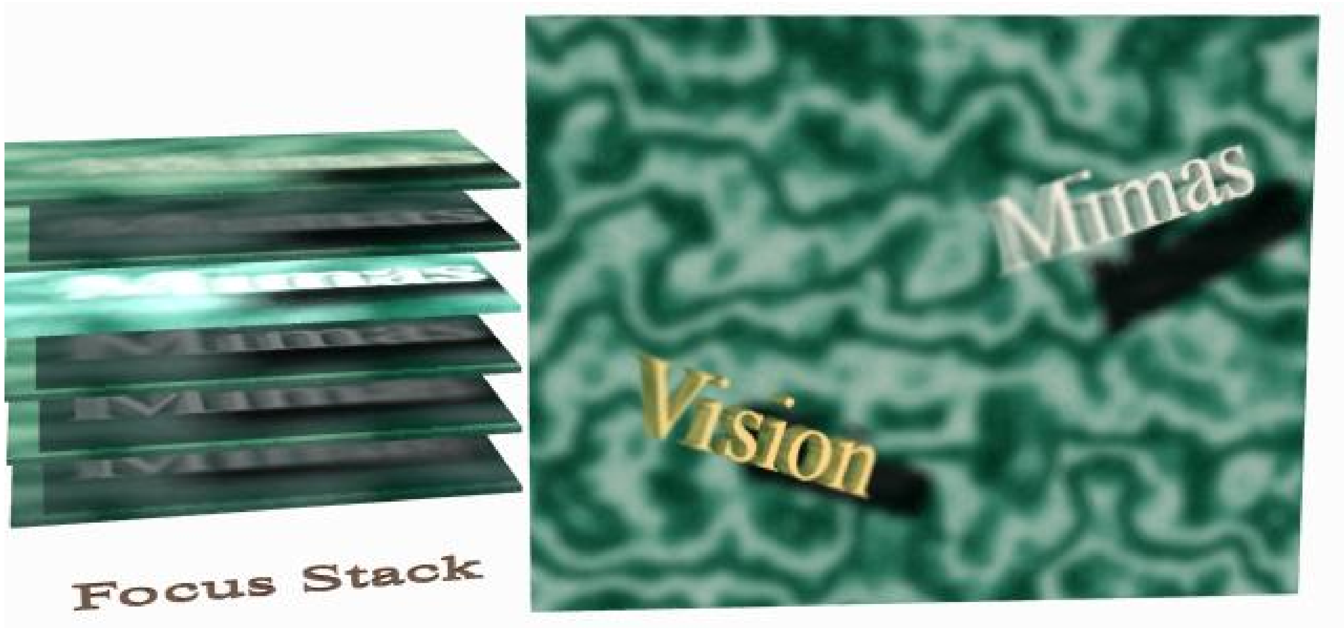
bounded hough transform

houghspace for relative shifts



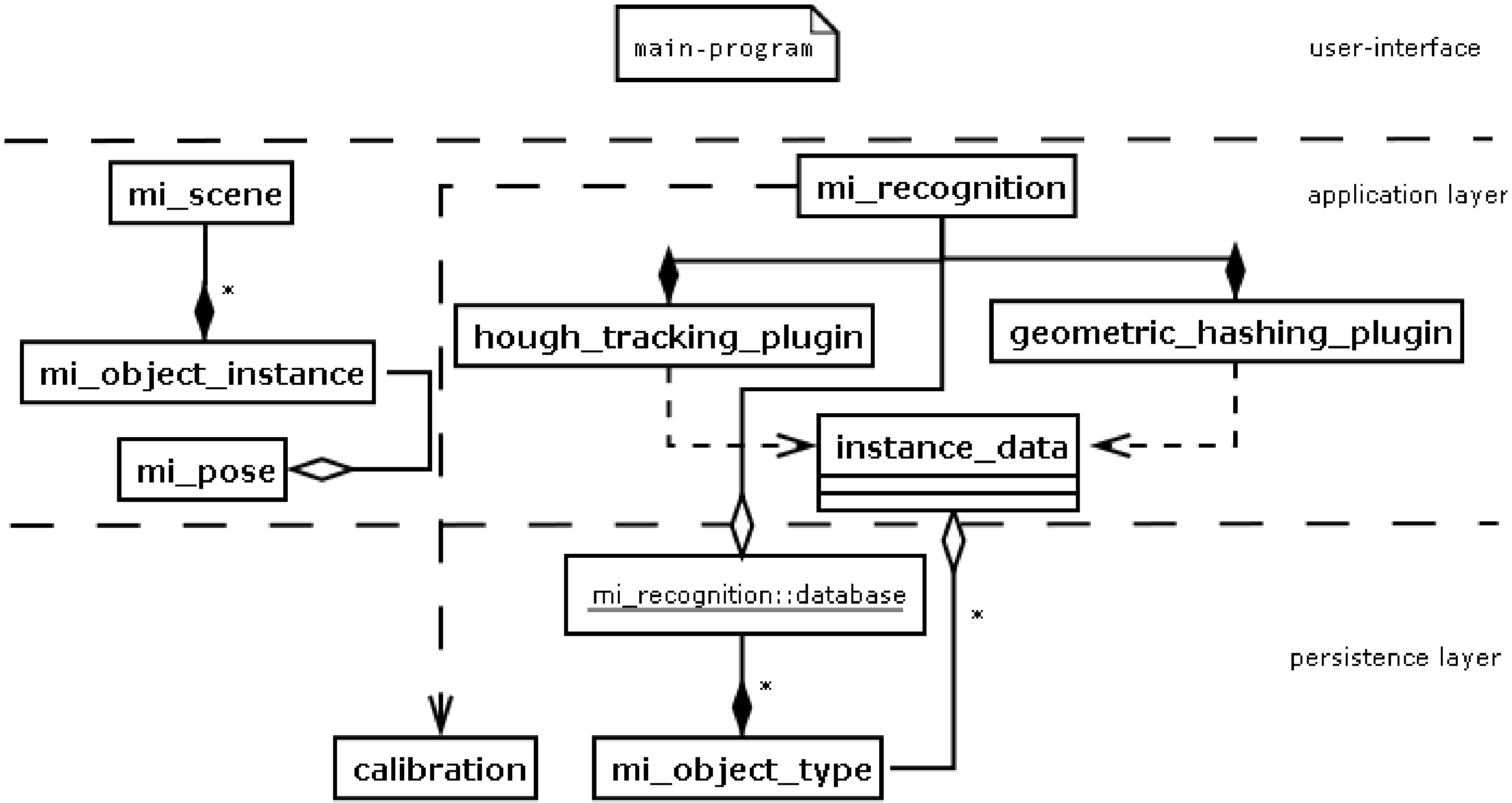
bounded hough transform

focus stacks for 4 DOF



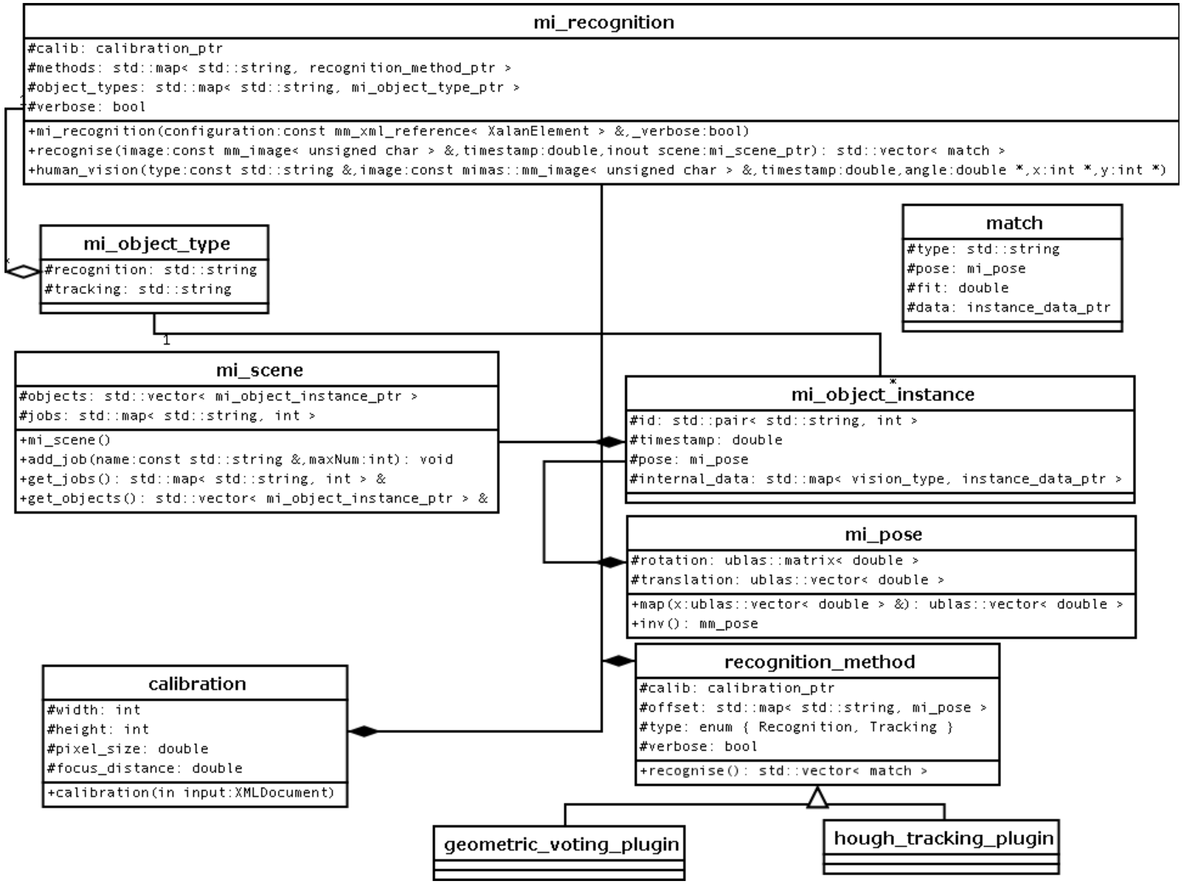
software architecture

application layers



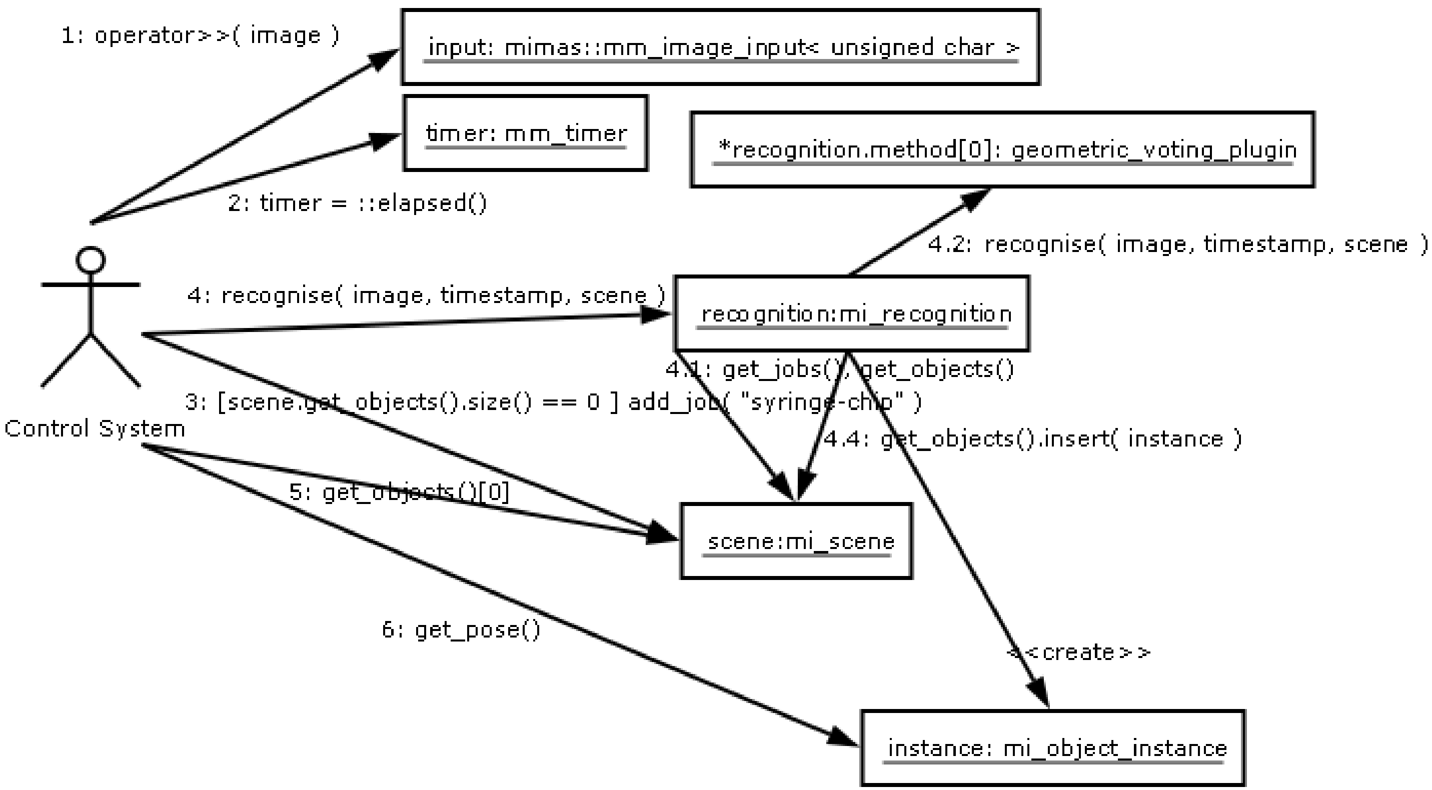
software architecture

UML static structure

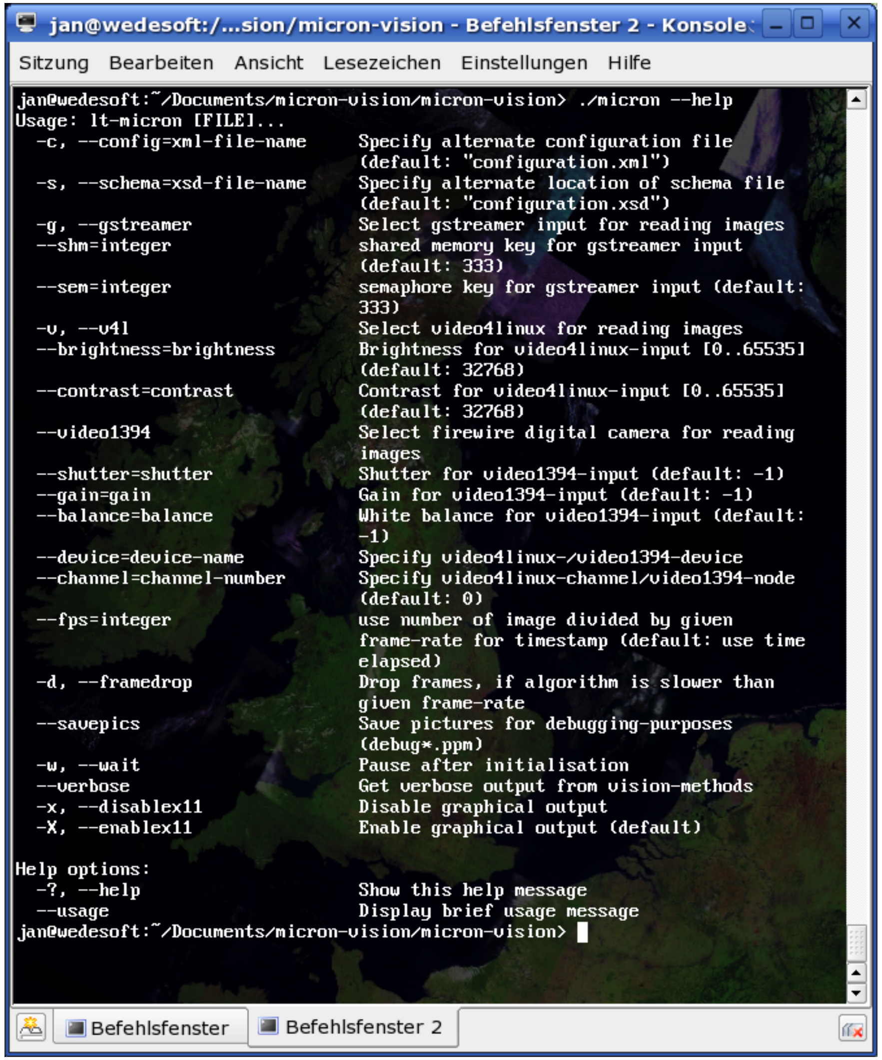


software architecture

UML collaboration diagram

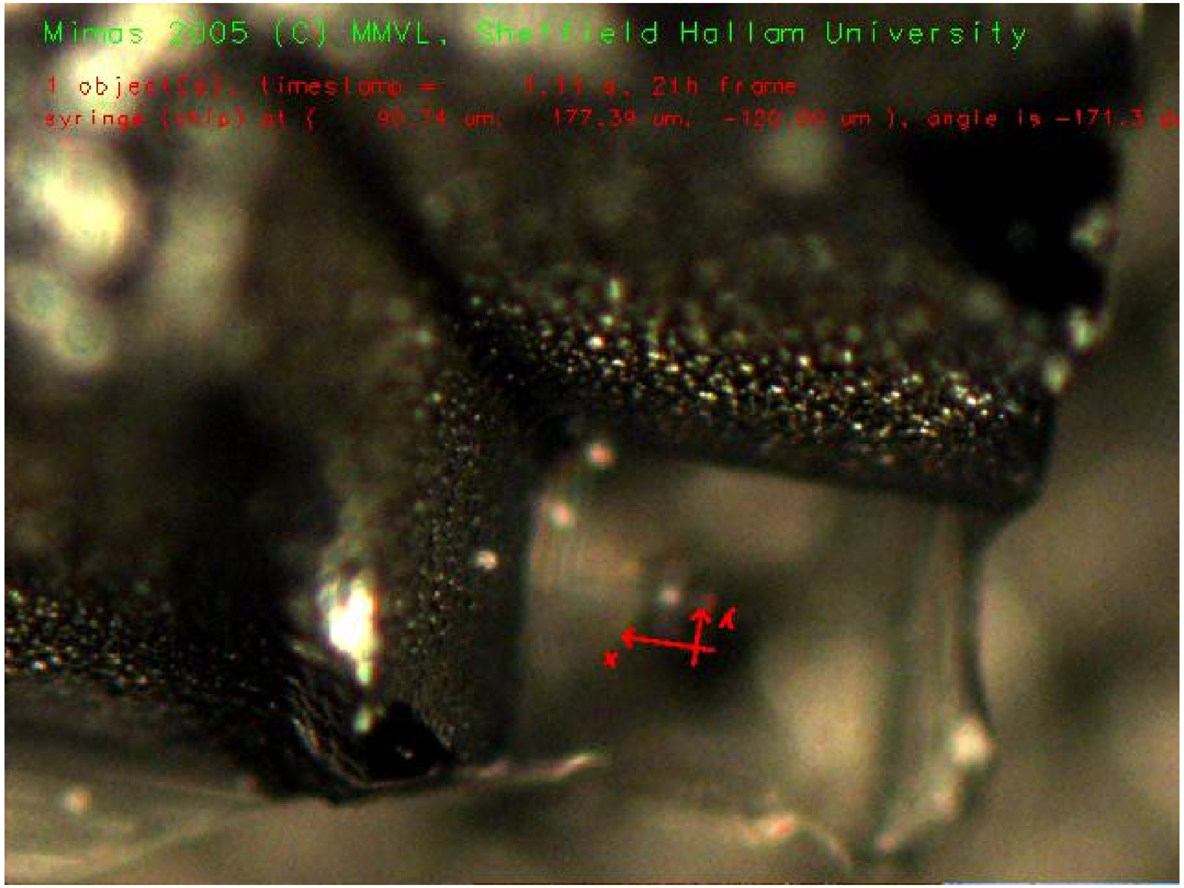


command-line tool



tests

syringe-chip



video

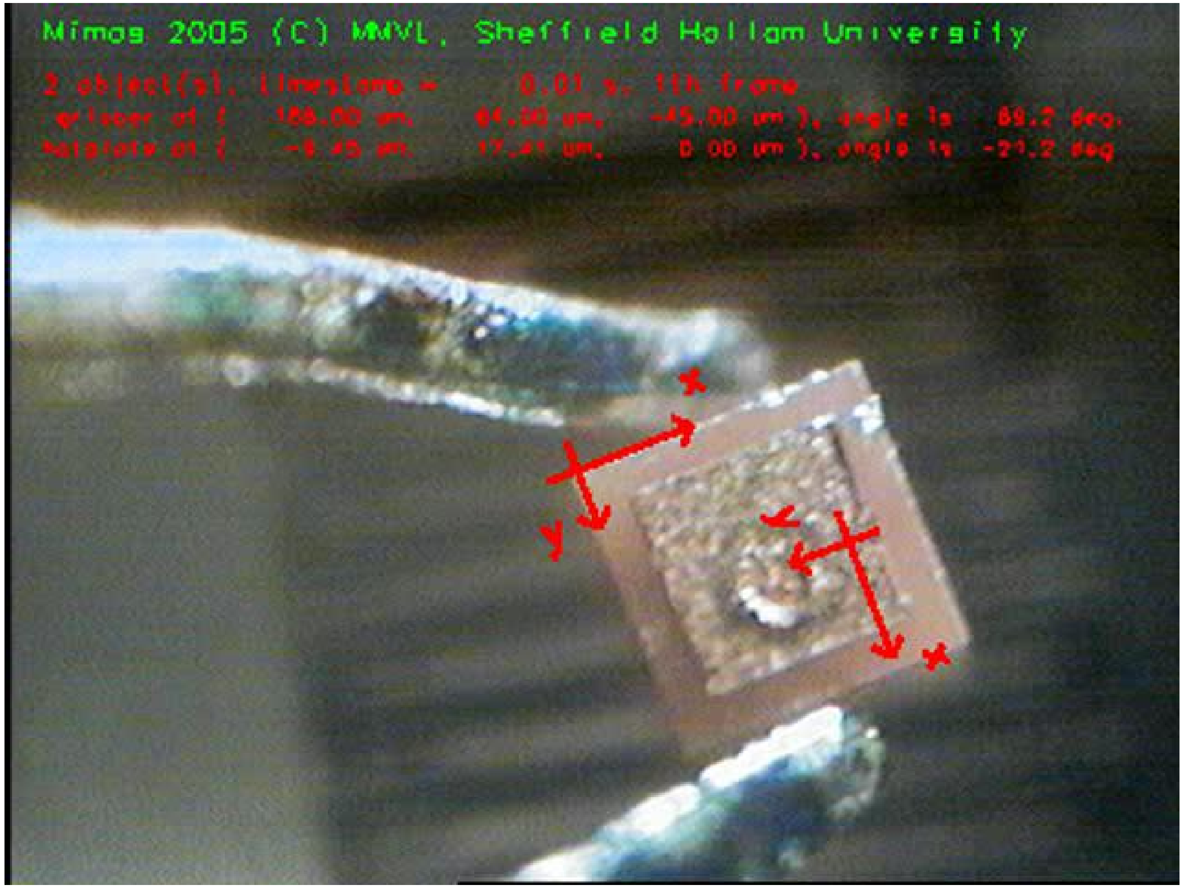
tests

gripper

video

tests

gripper2

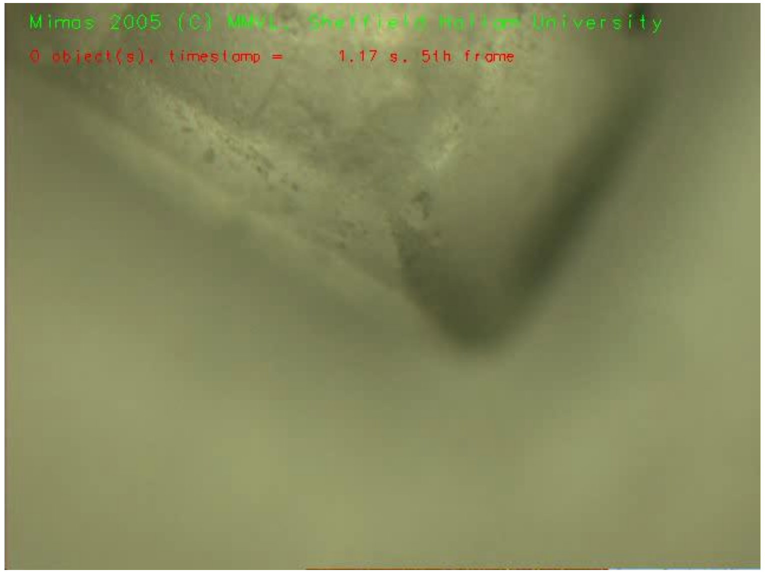


video

tests

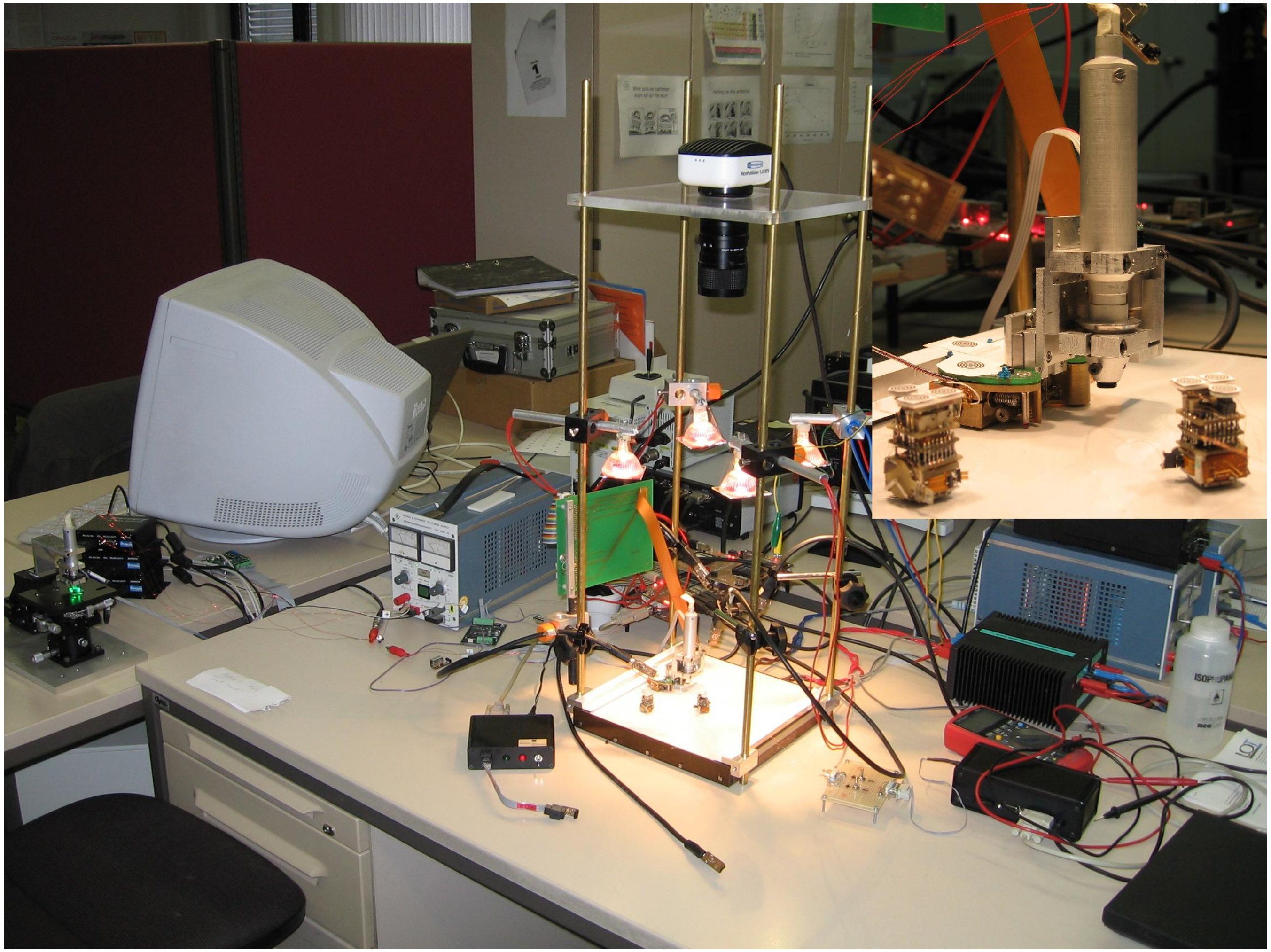
full automation

video

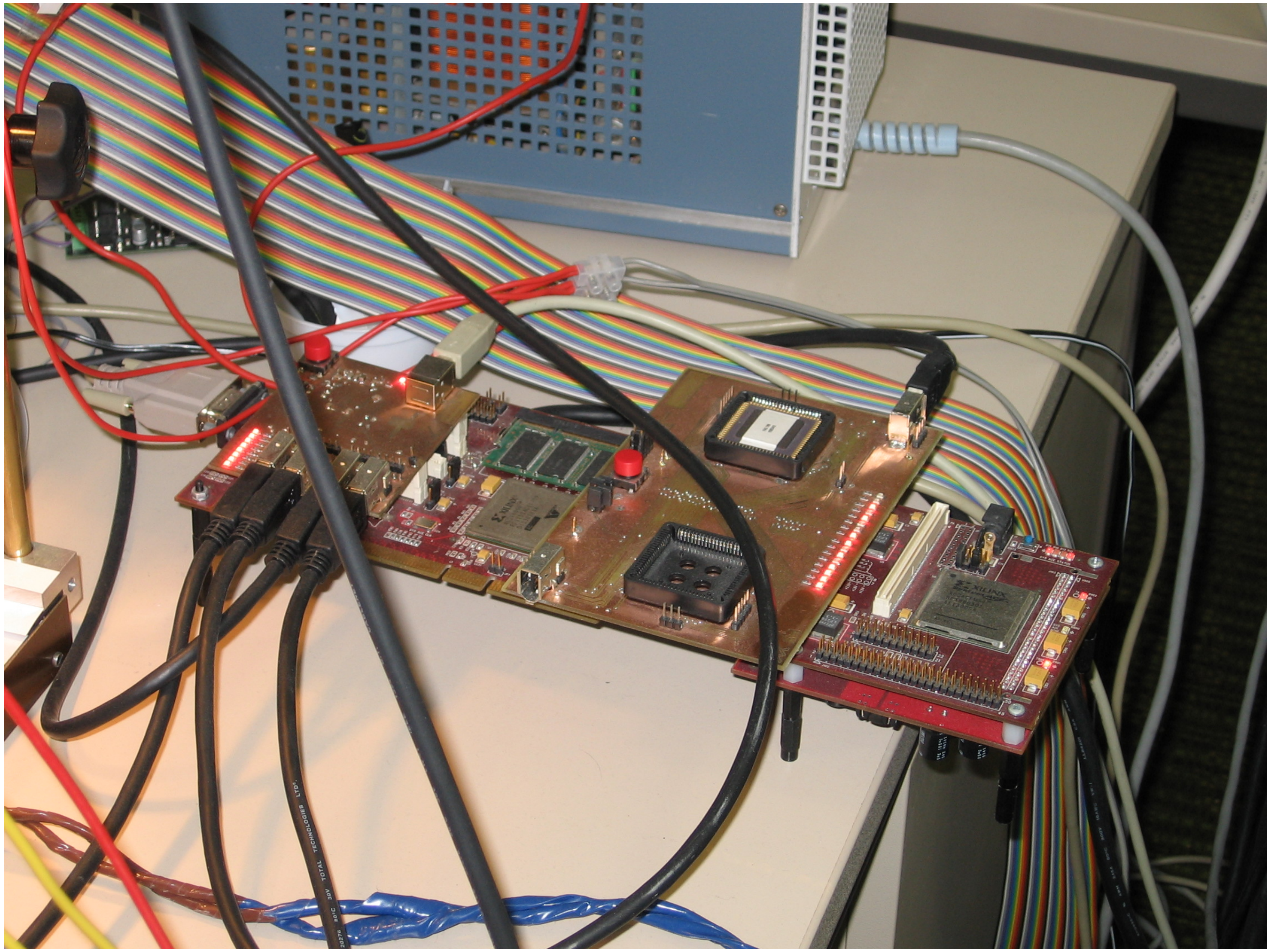


video

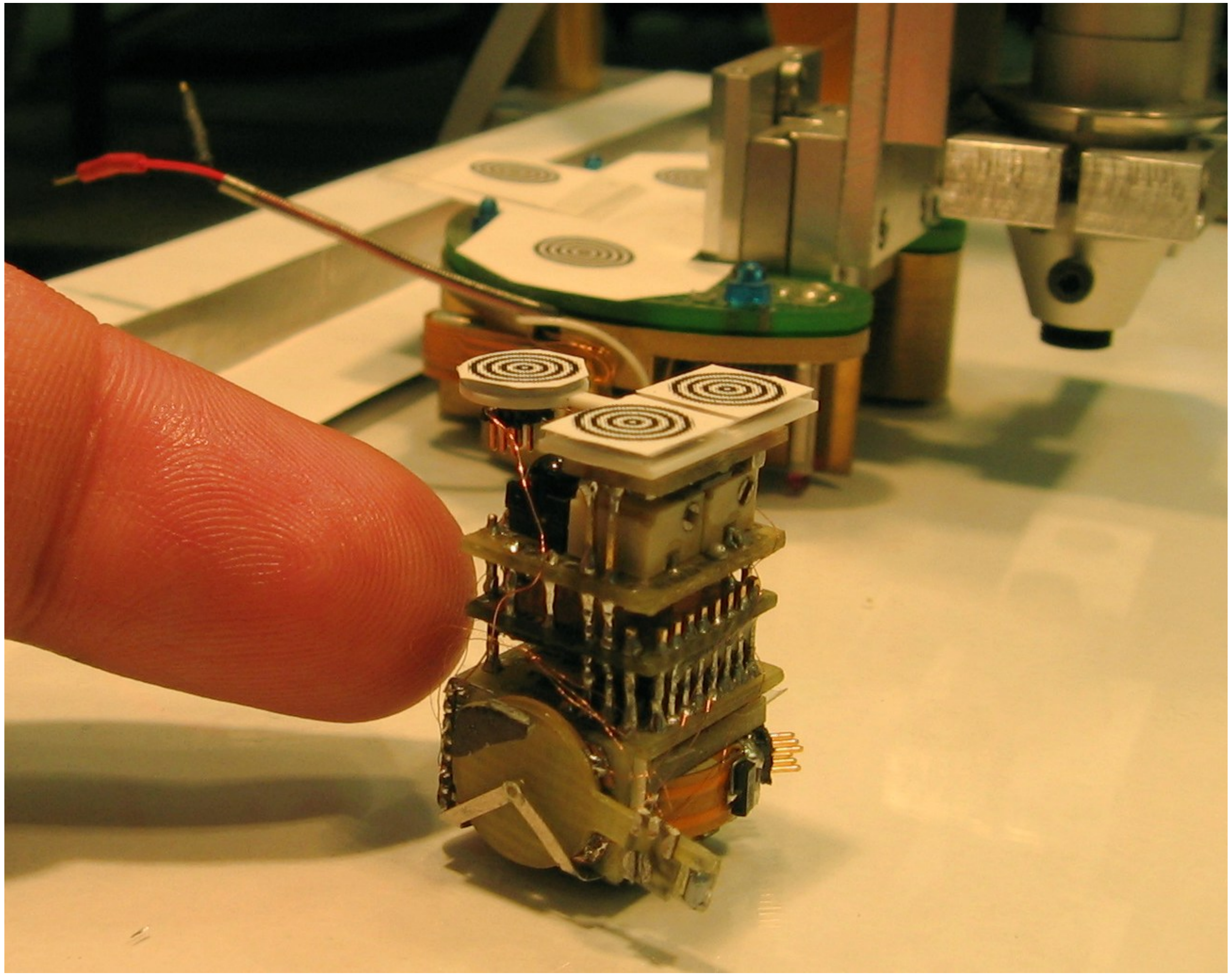
MiCRoN setup (i)



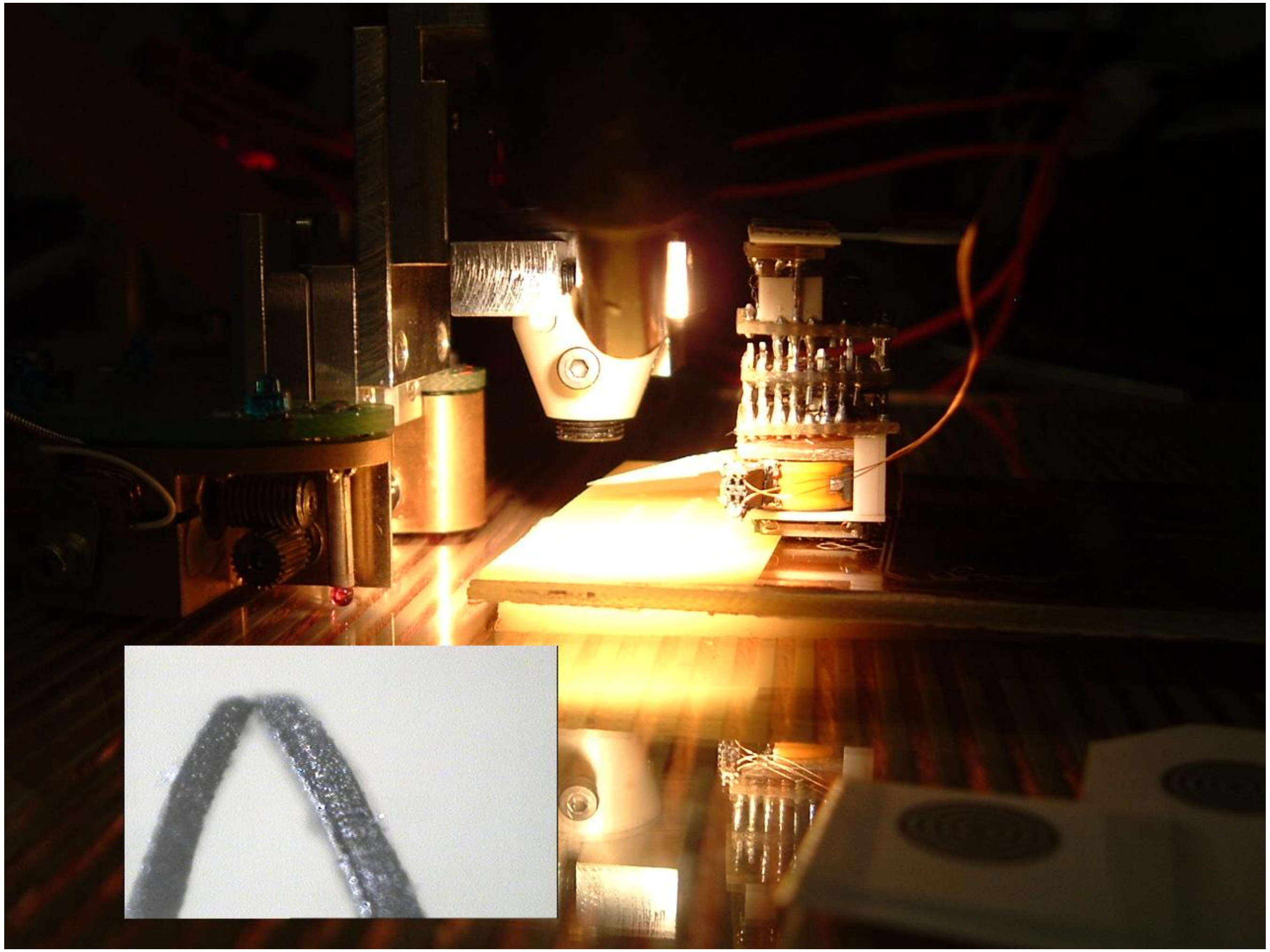
MiCRoN setup (ii)



MiCRoN setup (iii)

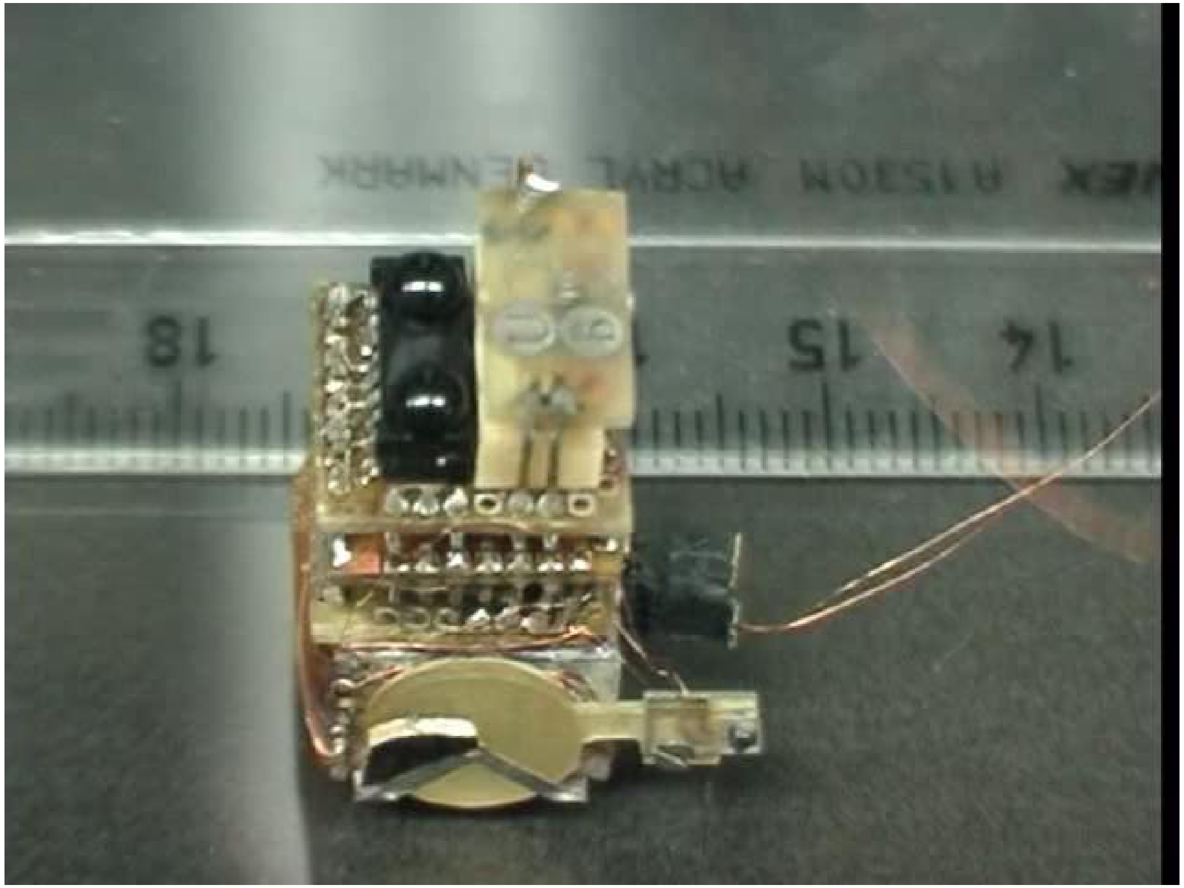


MiCRoN setup (iv)



MiCRoN

assembly mockup



video

MiCRoN

assembly mockup

video

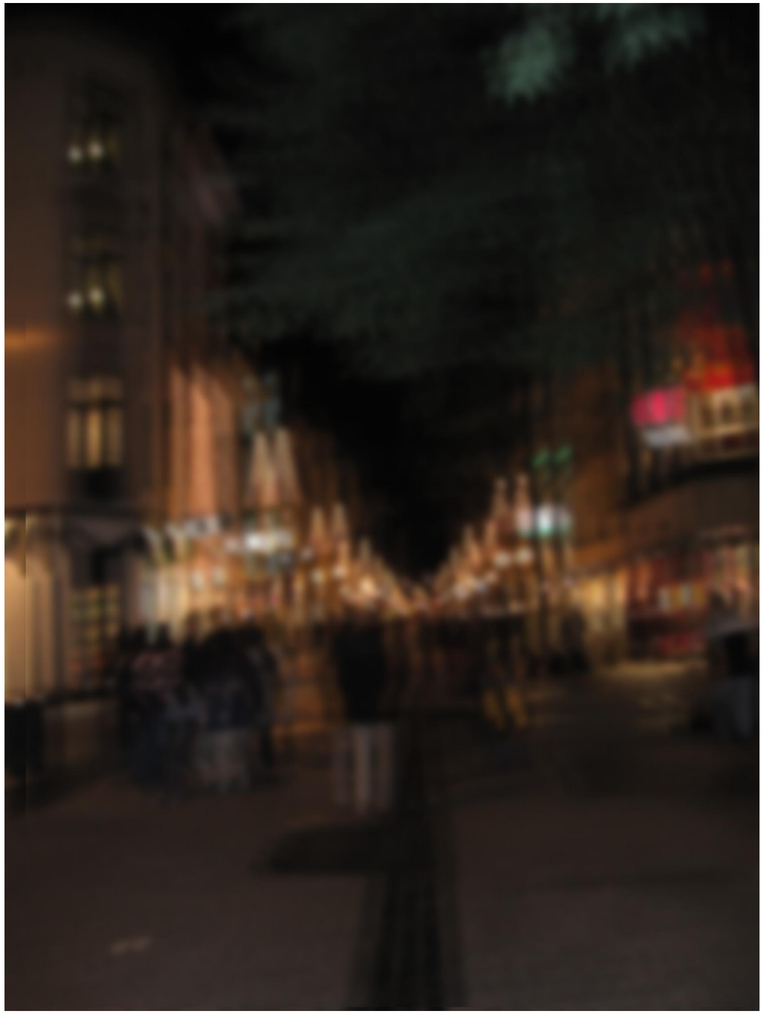
demonstration

macro-scale demonstration

acknowledgements

- Jon Travis: technical suggestions, administrative support
- Fabio Caparrelli: camera drive/electronics/driver software, electronics setup, PI driver software, management
- Balasundram Amavasai: proposal, computer vision suggestions, mimas long-term strategy
- Arul Selvan: students supervision, telecentric optics, shift estimation
- Manuel Boissenin: realtime tracking of multiple micro-objects, parallelisation
- Jan Wedekind: software architecture and integration, realtime recognition of multiple micro-objects

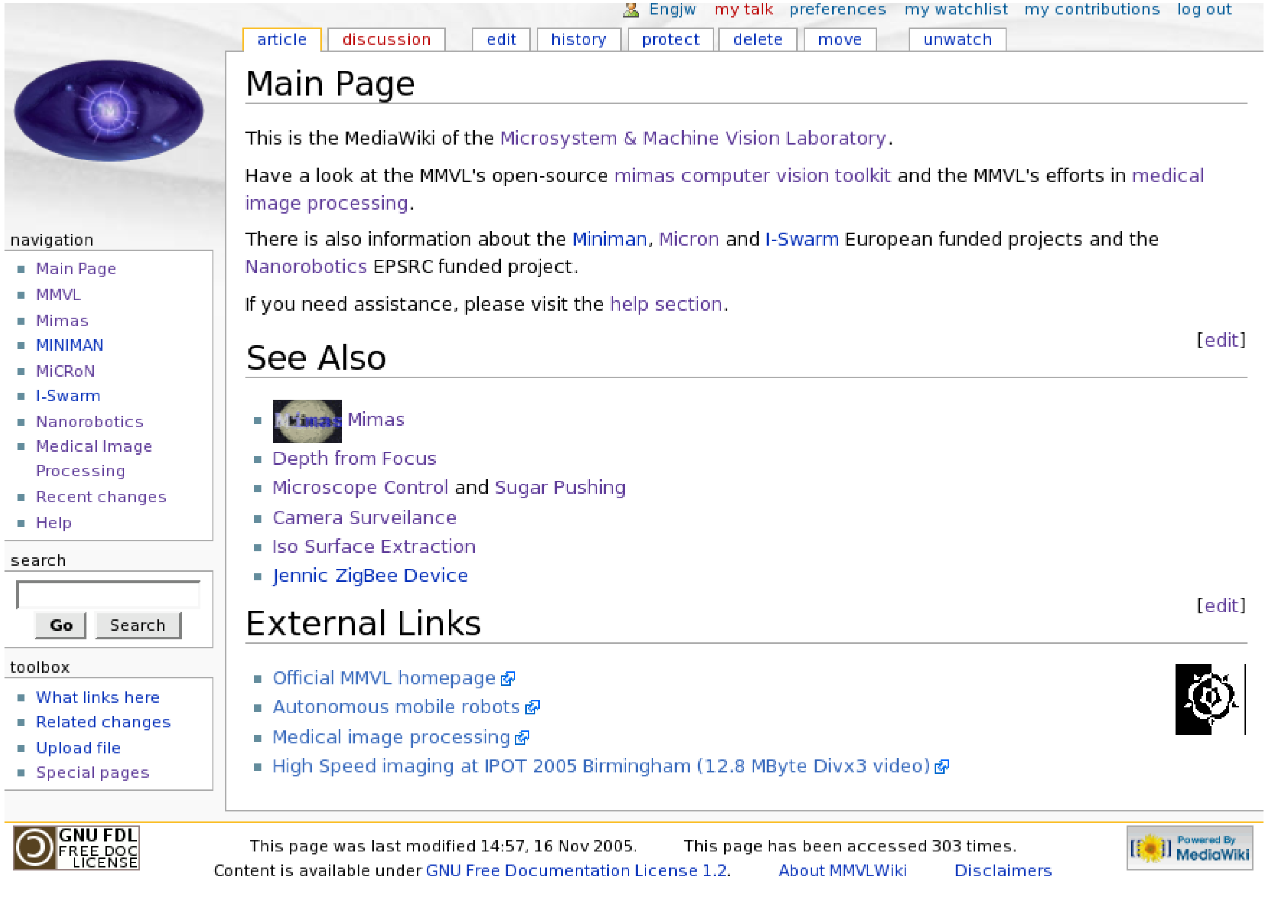

Attractive prices for UK tourists!*
200 CIGARET
AUSTIN 25.-
BURTON 24.-
CAMEL 2880
BENSON 26+33.-
ELIXIR 2750
GAULOISES 2880
WEST+DUCAL 2880
MARLBORO 33.-
SILK CUT 33.-
LAMBERT-BUTL. 33.-
250 CIGARET
HB 36.-
LUCKY STRIKE 36.-
+ BRIQUET




COR JESU
BONITATE ET AMORE PLENUM . M.N

Happy Christmas!

http://vision.eng.shu.ac.uk/mediawiki/



Upcoming: MiCRoN public final report