Capturing 500 fps range data of bats

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Special acknowledgements: Yijun Xiao

High Speed Stereo 3D Capture

Dimensional Imaging stereo camera system

500 Frames per second

Infrared sensitive cameras

Extra infrared light panels

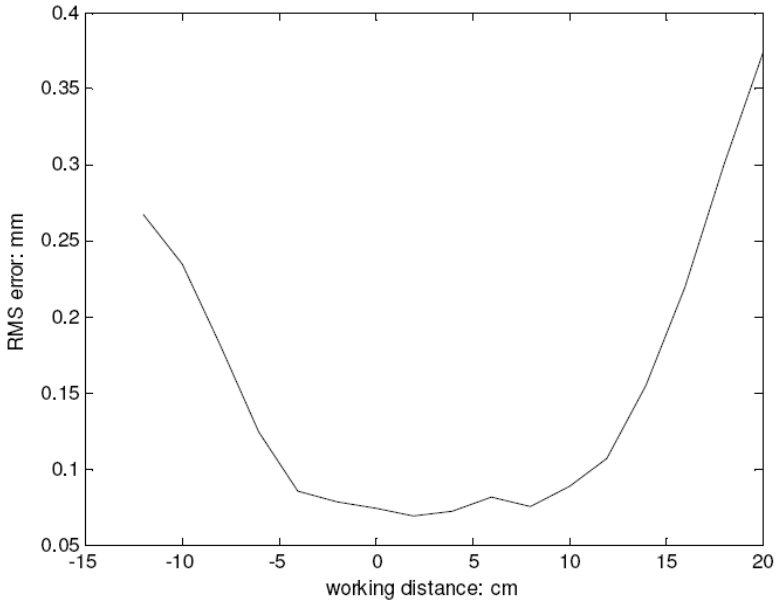
Post-capture 3D dense stereo calculation

Static Performance Characterisation

Unique custom designed sensor

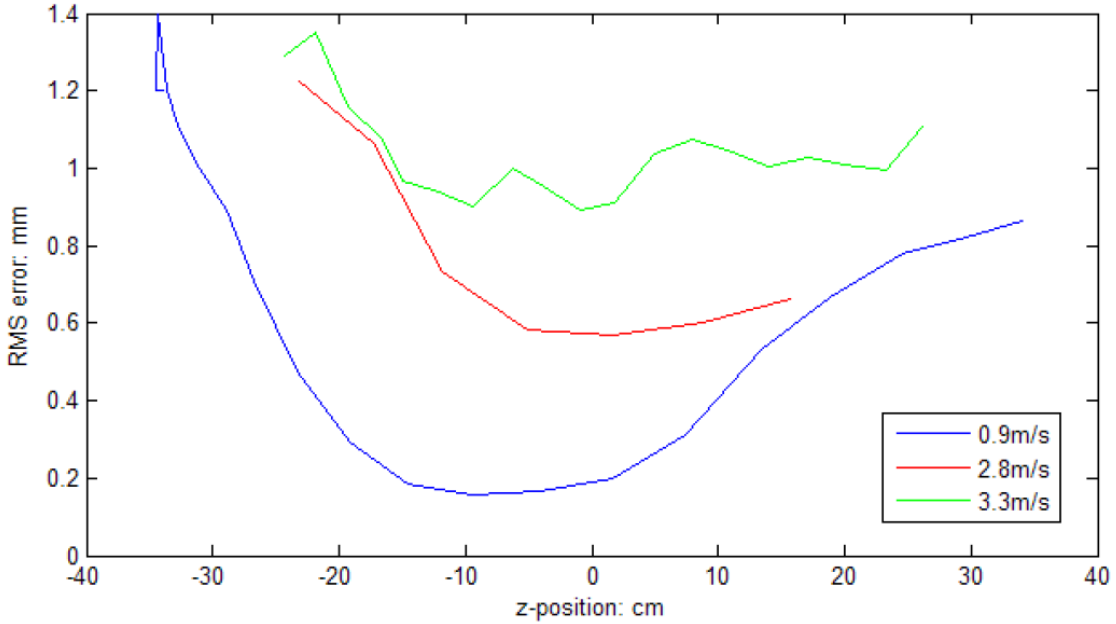
Performance characterisation

Capture zone:



Gets 0.15 mm RMS over 20 cm range: static targets

Moving Target Performance



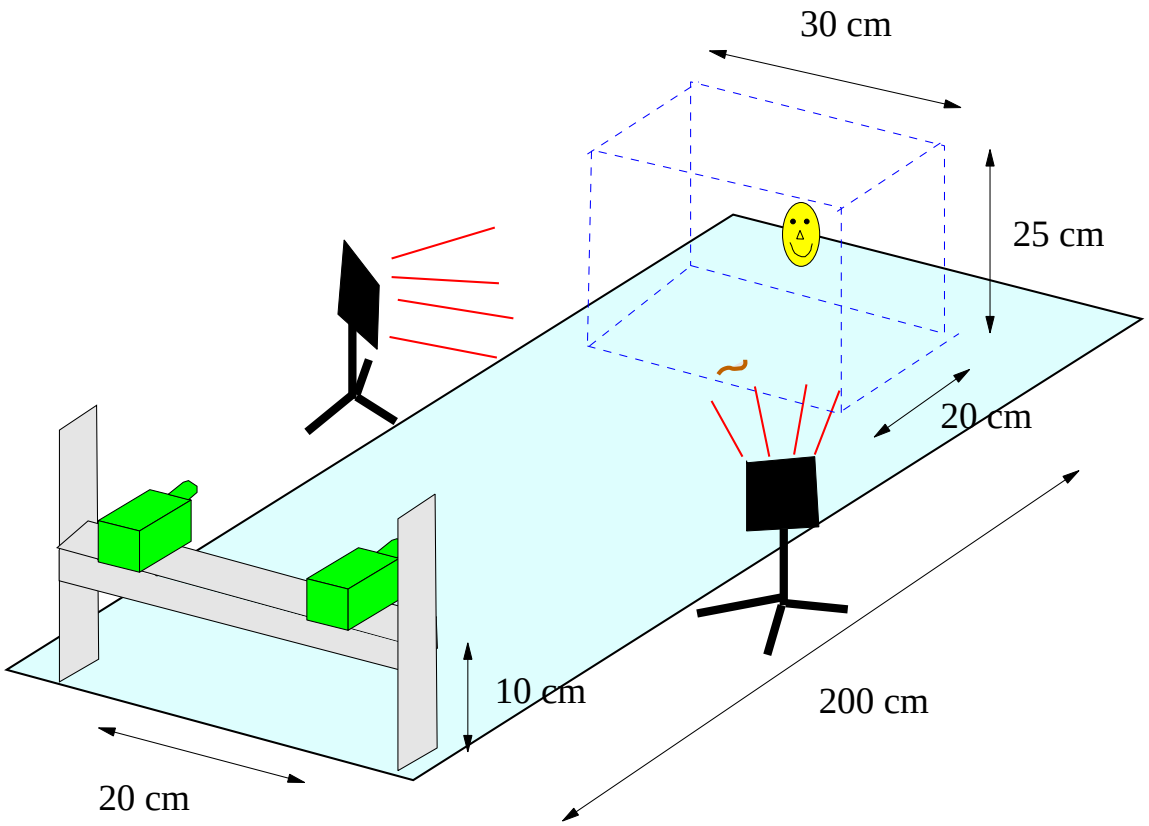
RMS 0.2 - 1.0 mm for looming speeds up to 3.3 m/s

RMS 0.75 mm for vertical speeds up to 5 m/s

RMS 1.4 mm for horizontal speeds up to 2.8 m/s

RMS 0.15 mm over 20 cm depth of field for static targets

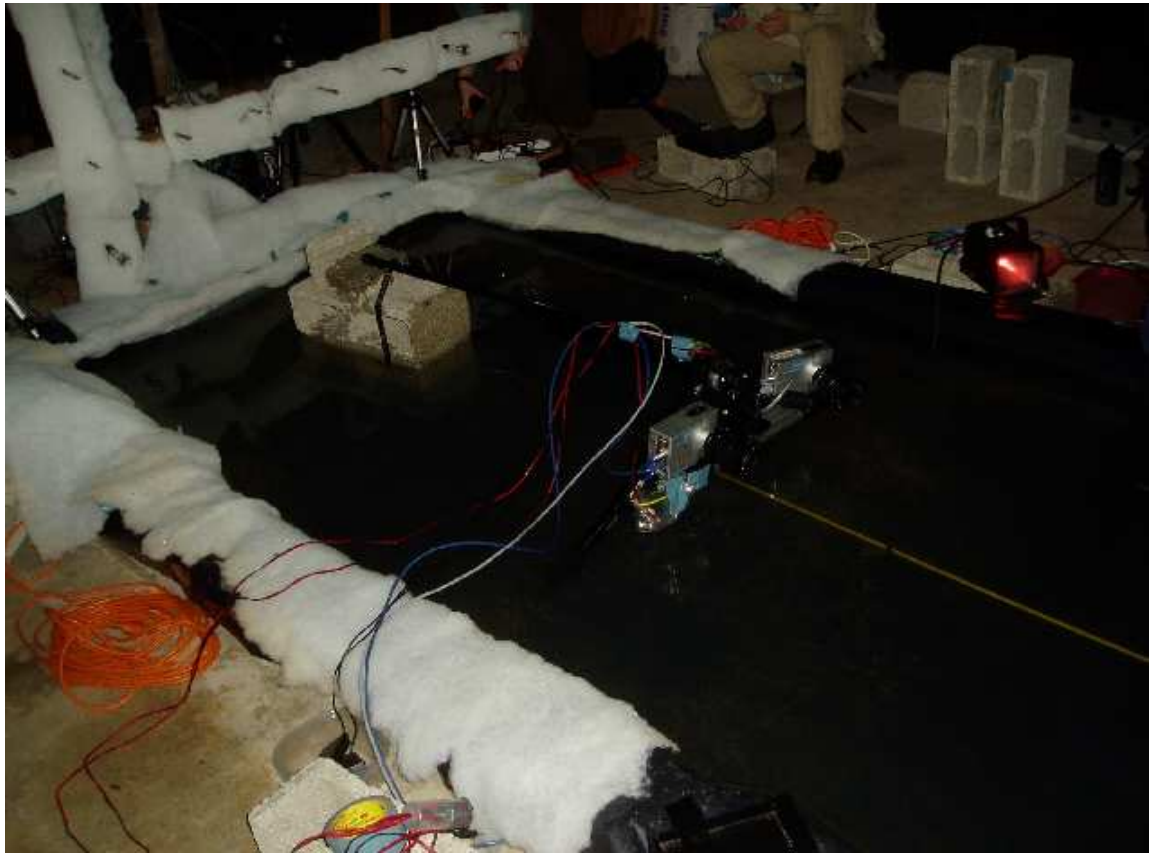
Bat data capture Ia



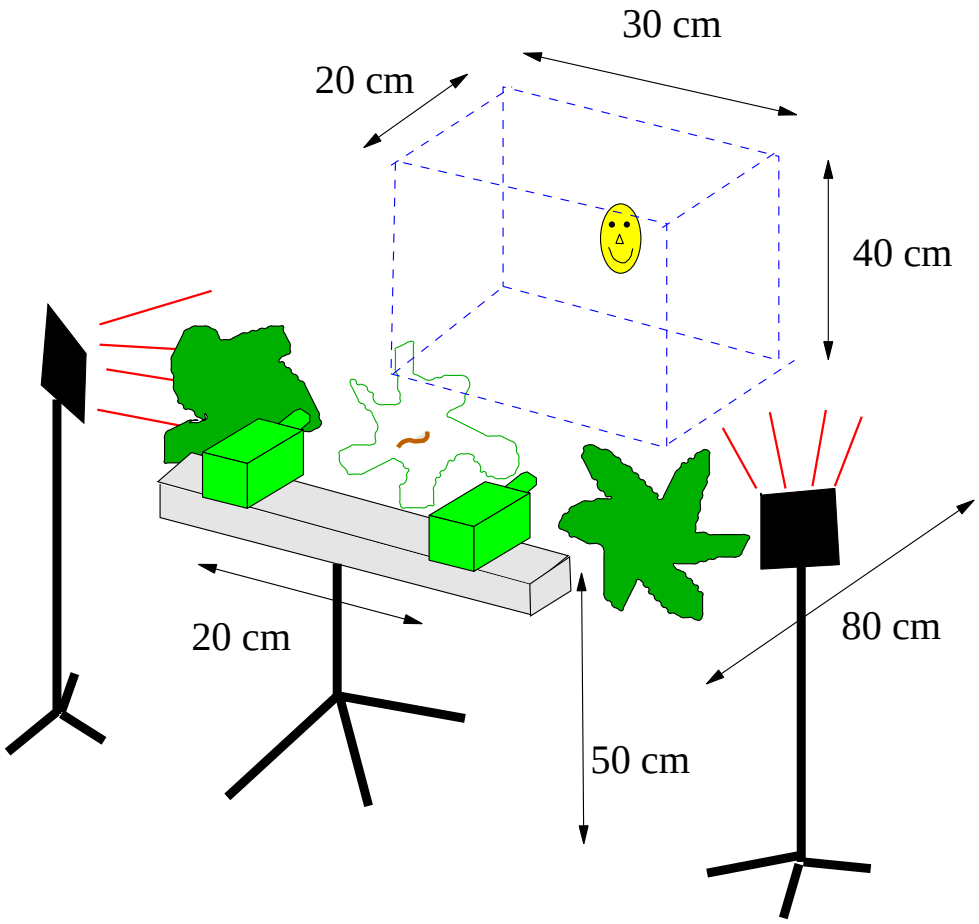
Trawling bats, eg: *Myotis daubentonii*, *Noctilio leporinus*, *Macrophyllum macrophyllum*

Bat data capture Ib

Bat data capture Ic

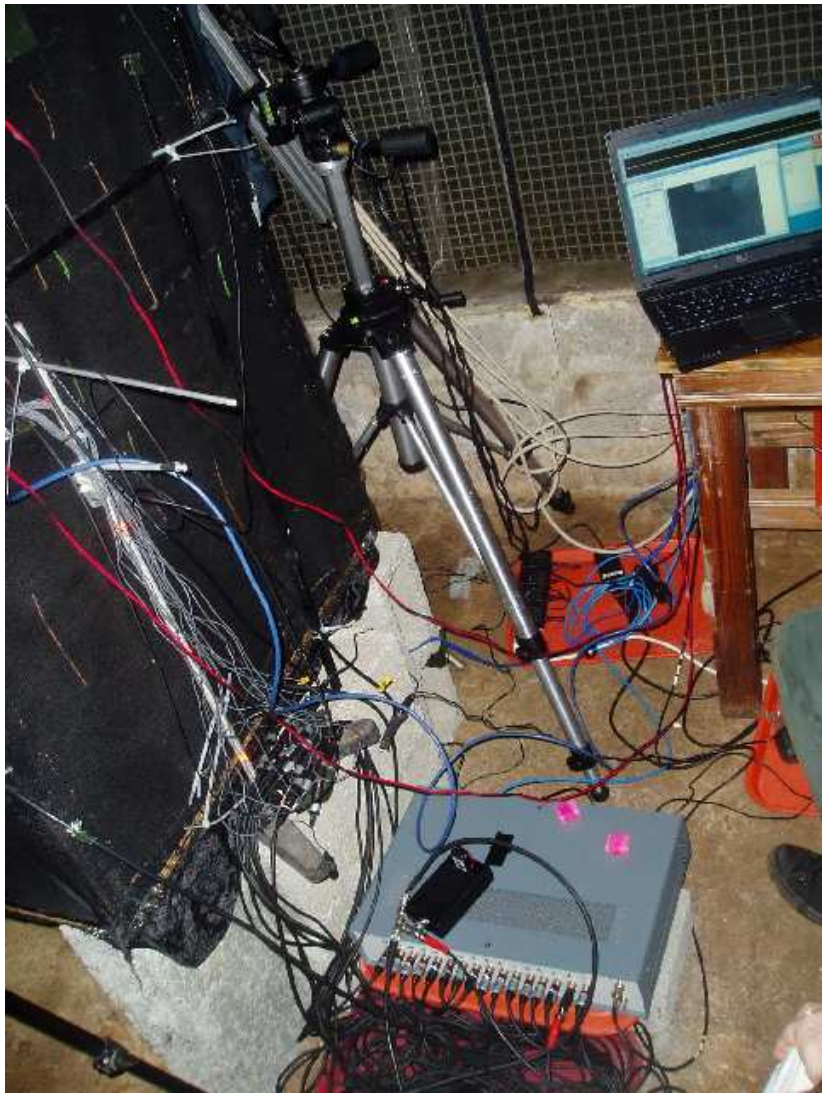


Bat data capture IIa



Scanning bats, eg: *Micronycteris microtis*

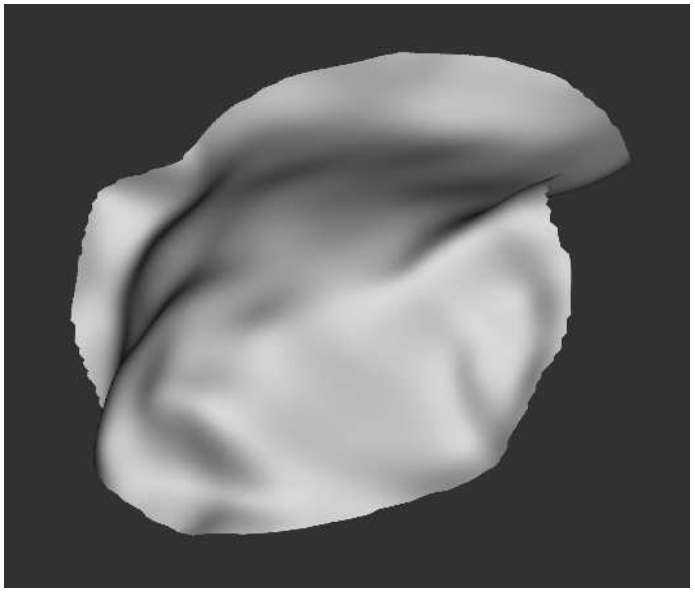
Bat data capture IIb



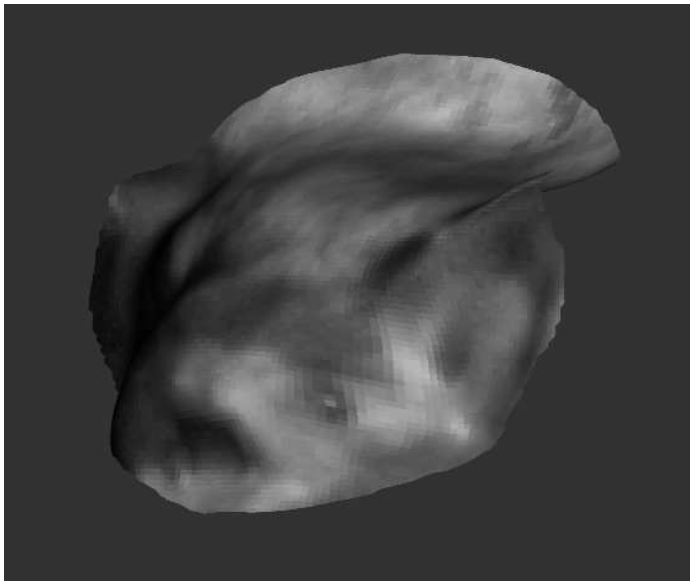
Bat Data Summary

Species	Season	Usable	Labeled
M. daubentonii	2008	3	3
N. leporinus	2009	76	76
M. macrophyllum	2009	40	28
M. microtis	2009	20	20
M. daubentonii	2009	74	10
N. leporinus	2010	in progress	in progress
M. macrophyllum	2010	in progress	in progress
M. microtis	2010	in progress	in progress

Bat data 3D surface capture



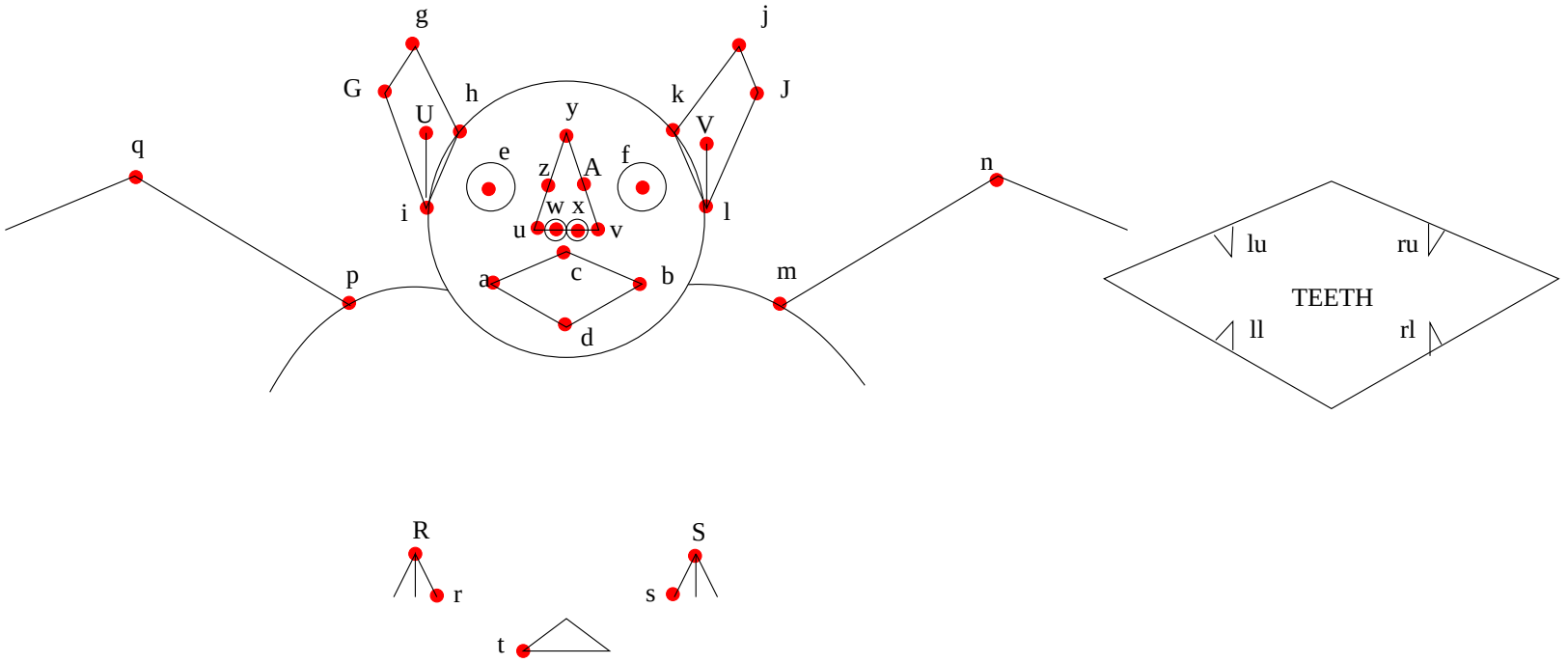
Cosine shaded 3D



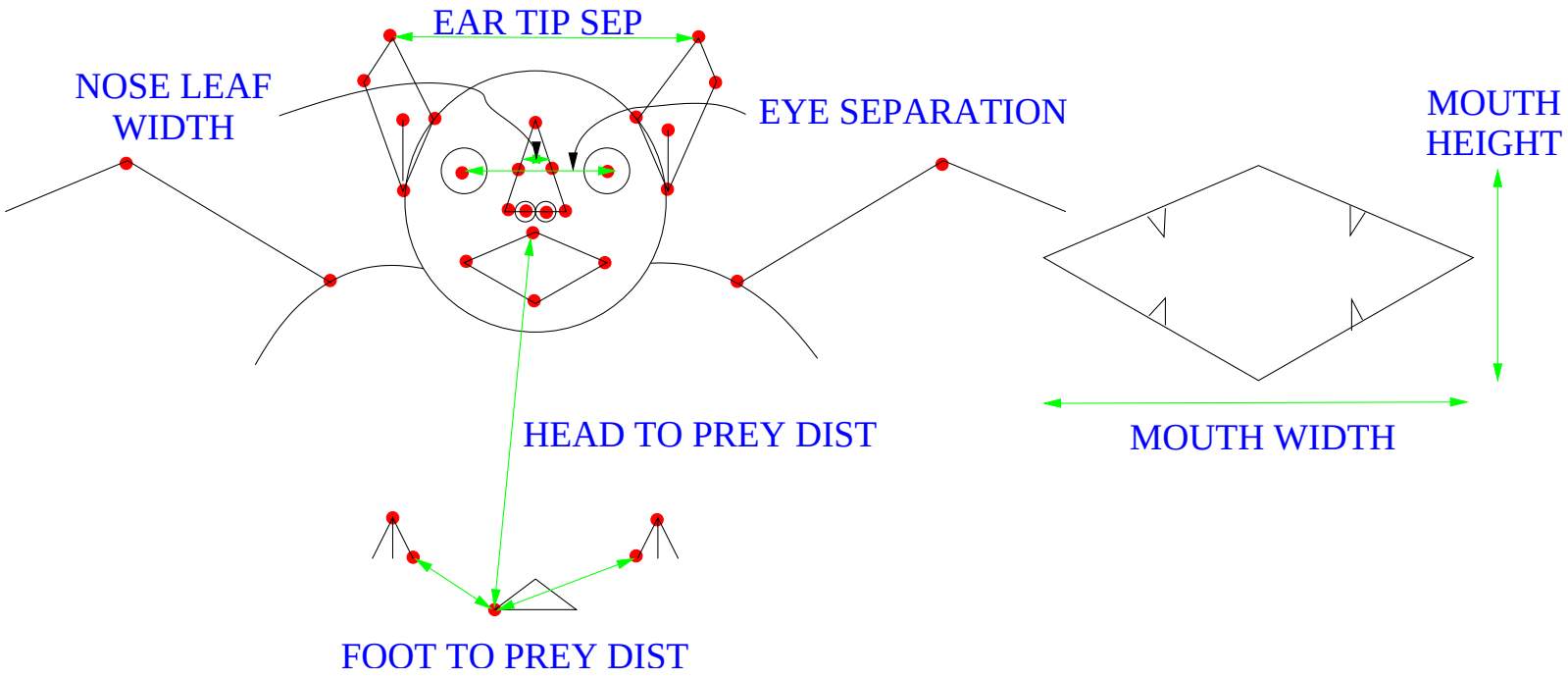
Texture mapped

See videos

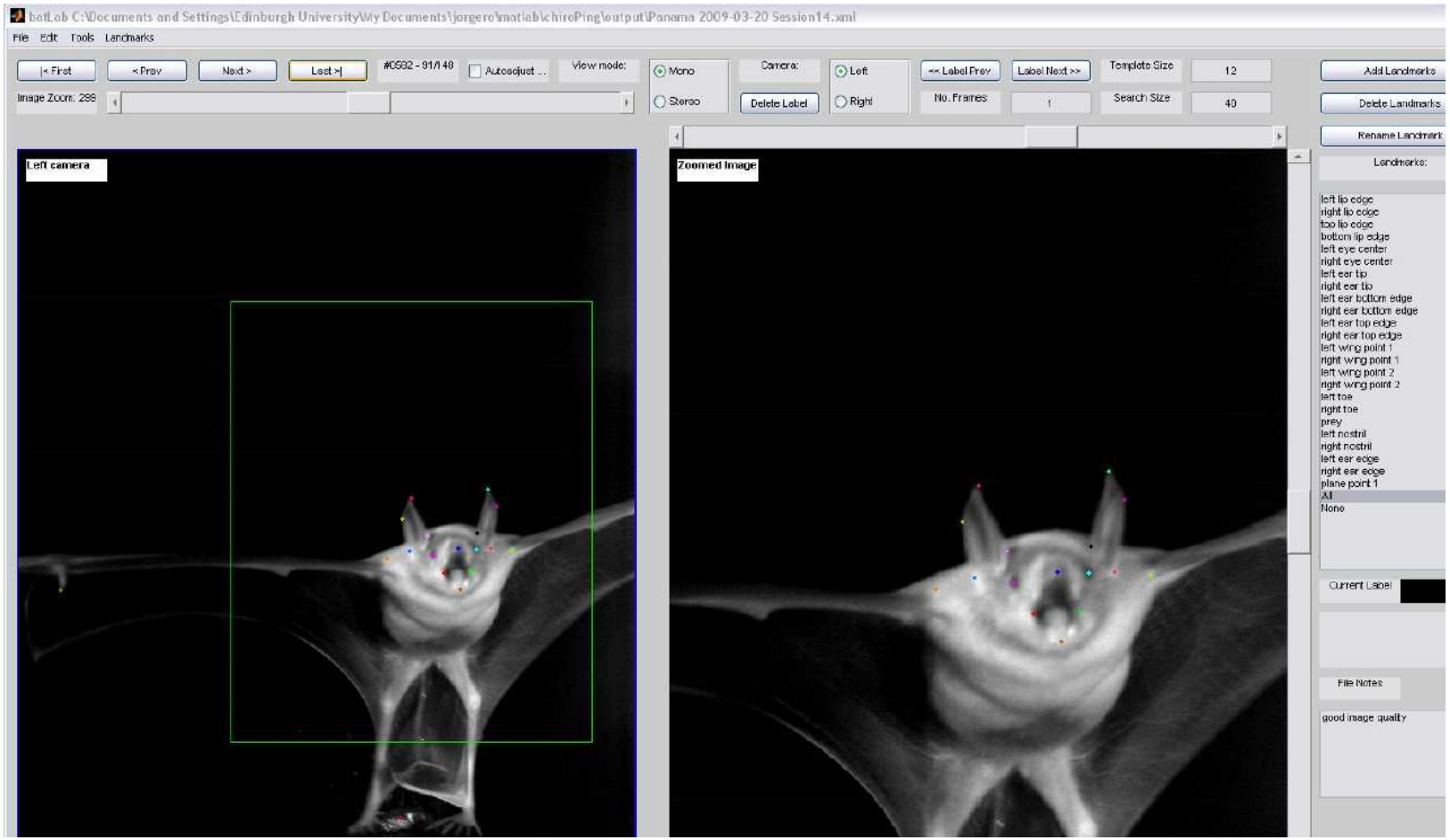
Interesting 2D Points



Some Bat Sequence Measurements



Markup Tool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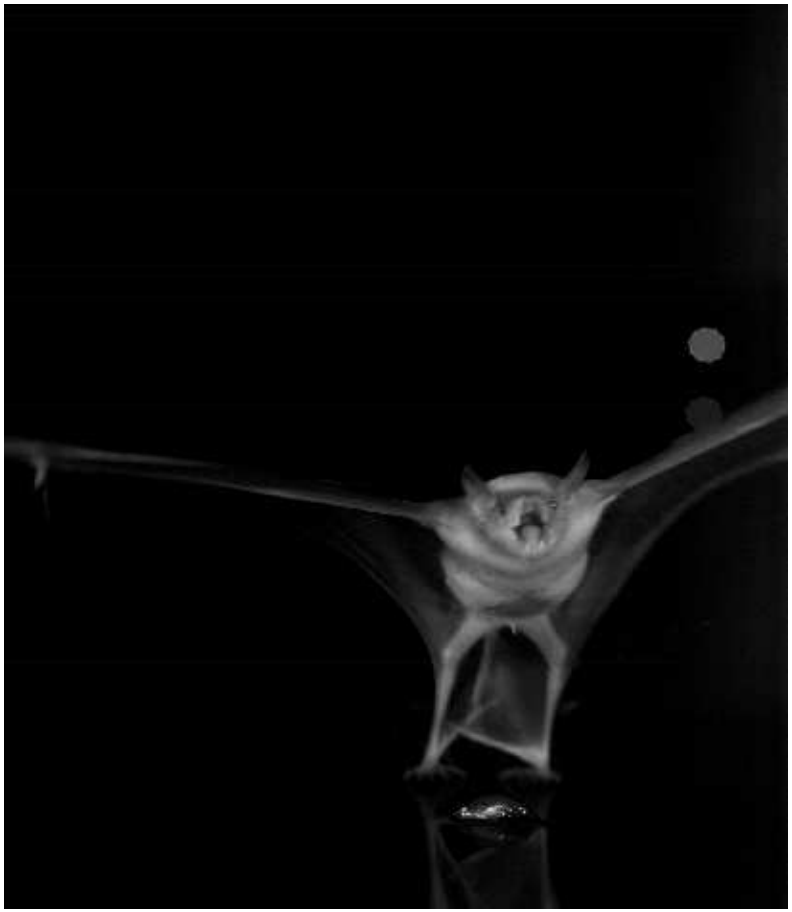
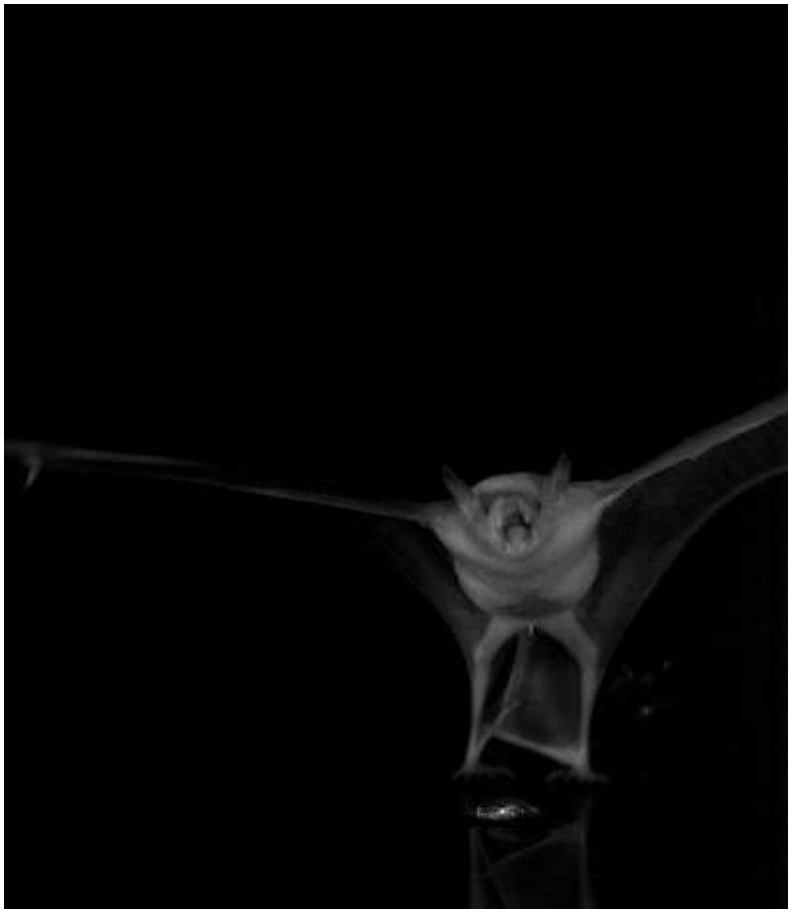
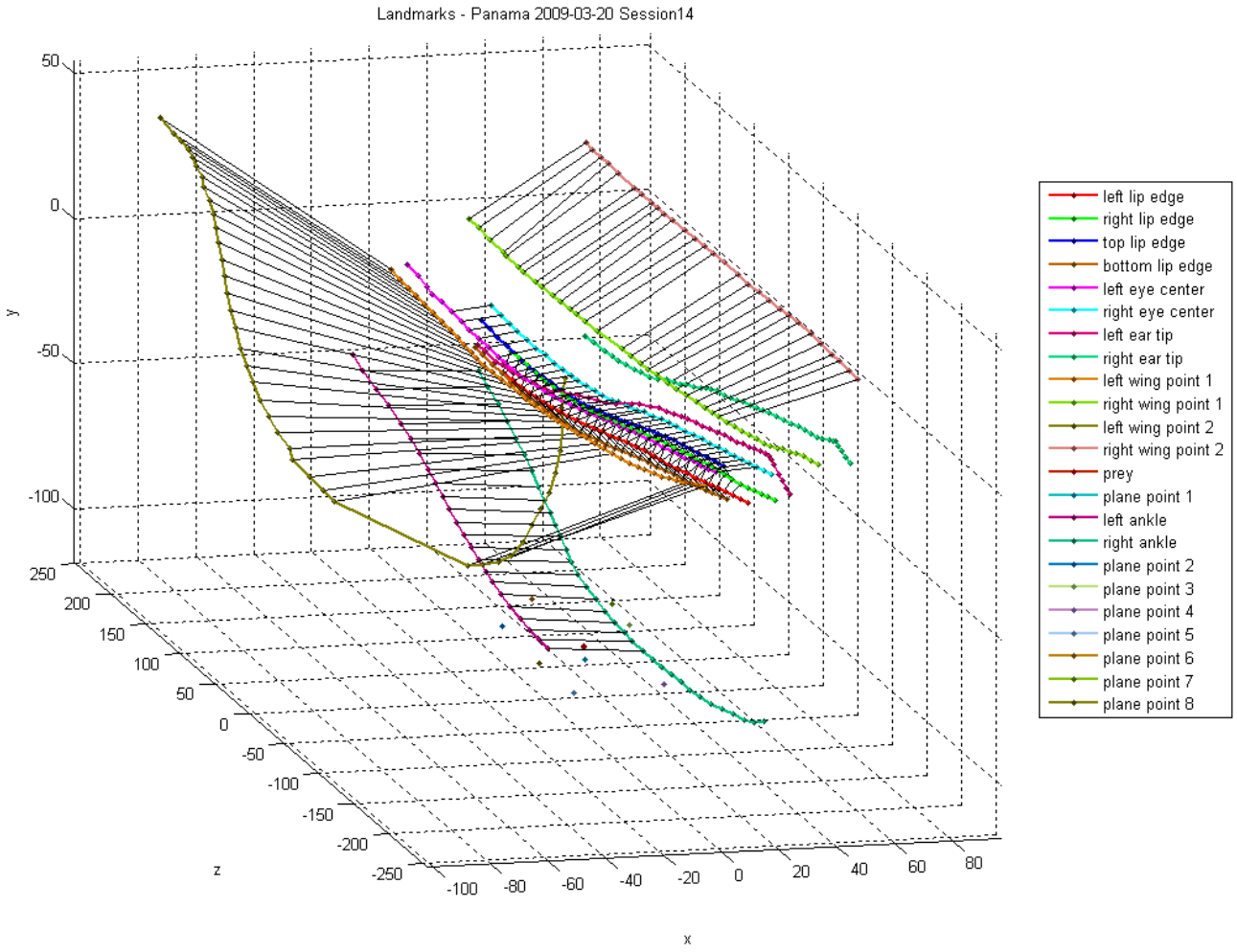
File Edit Tools Landmarks
|< First
< Prev
Next >
Last >|
#0592 - 91/148
Autoadjust ...
View mode:
Mono
Stereo
Camera:
Left
Right
Delete Label
<< Label Prev
Label Next >>
No. Frames
Template Size
12
Search Size
40
Add Landmarks
Delete Landmarks
Rename Landmark
Image Zoom: 288
Left camera
Zoomed Image
Landmarks:
left lip edge
right lip edge
top lip edge
bottom lip edge
left eye center
right eye center
left ear tip
right ear tip
left ear bottom edge
right ear bottom edge
left ear top edge
right ear top edge
left wing point 1
right wing point 1
left wing point 2
right wing point 2
left toe
right toe
prey
left nostril
right nostril
left ear edge
right ear edge
plane point 1
All
None
Current Label
File Notes
good image quality

Noctilio leporinus





N. leporinus Sequence 14 3D Trajectory



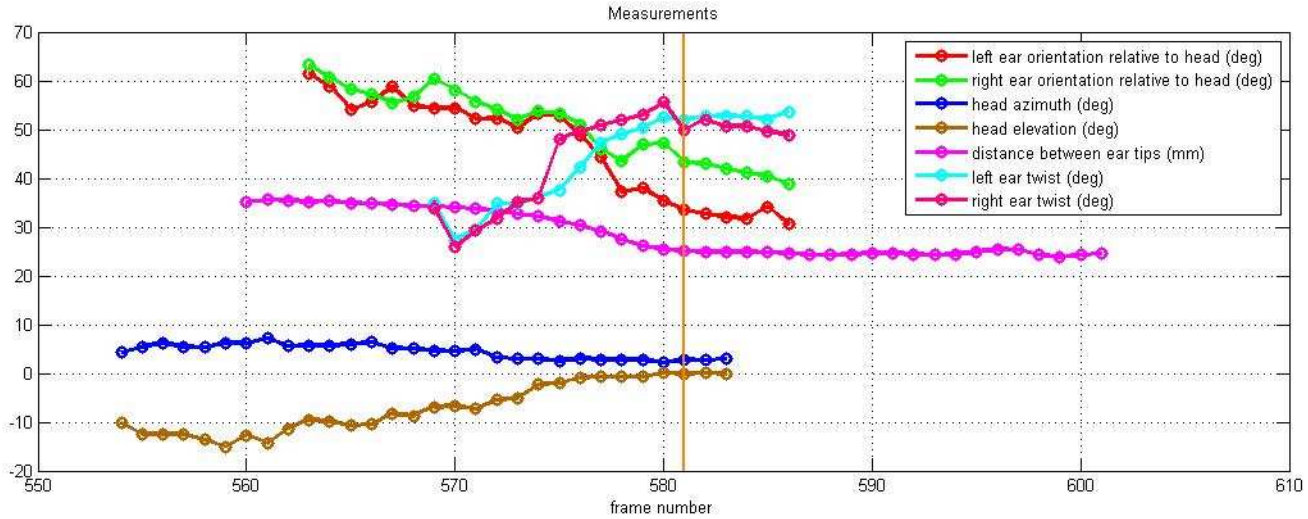
Computer Vision and Science?

All nice fun, but what about Science?

...

And Computer Vision?

N. leporinus **Ears - 20/3/09 #14**



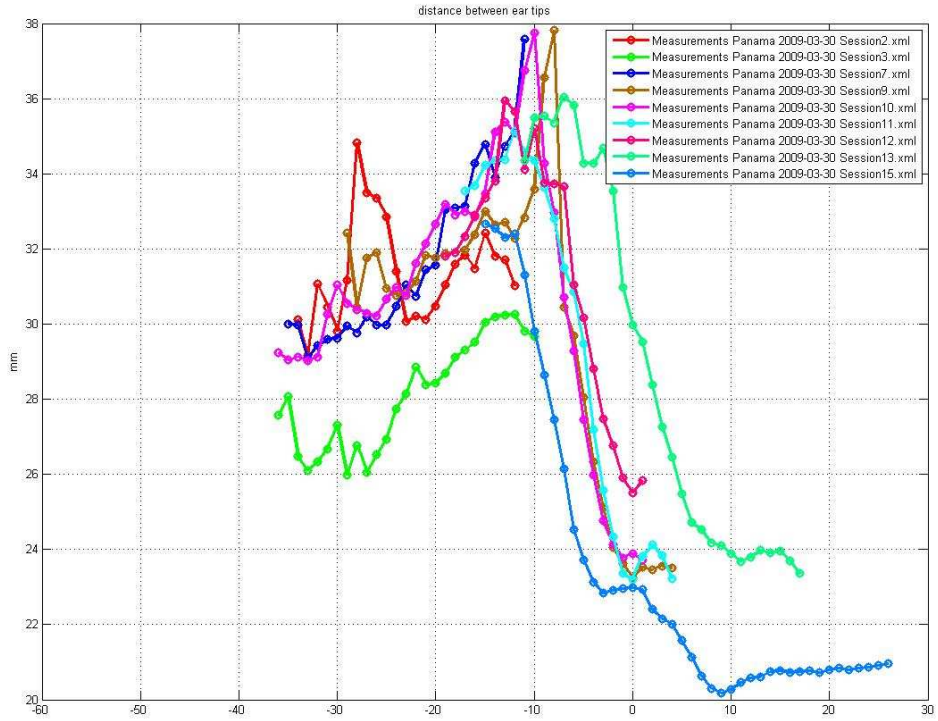
Ears raise (red,green) and twist outward (cyan,red)

Ear separation (pink) reduces

Bat flies forward (blue) and tilts up (brown)

Vertical bar (tan) is prey contact frame

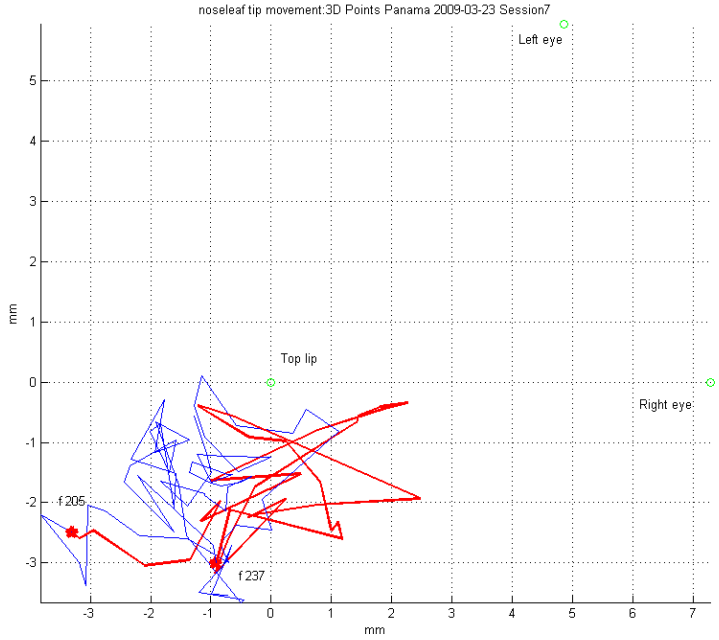
All *N. leporinus* Ear Separation - 30/3/09



0 is estimated prey contact frame

Micronycteris microtis

M. microtis - 23/3/09 #7



Noseleaf maximum dip at 205 & 237

Seems to be moving around

Aiming for biosciences publications with teammates

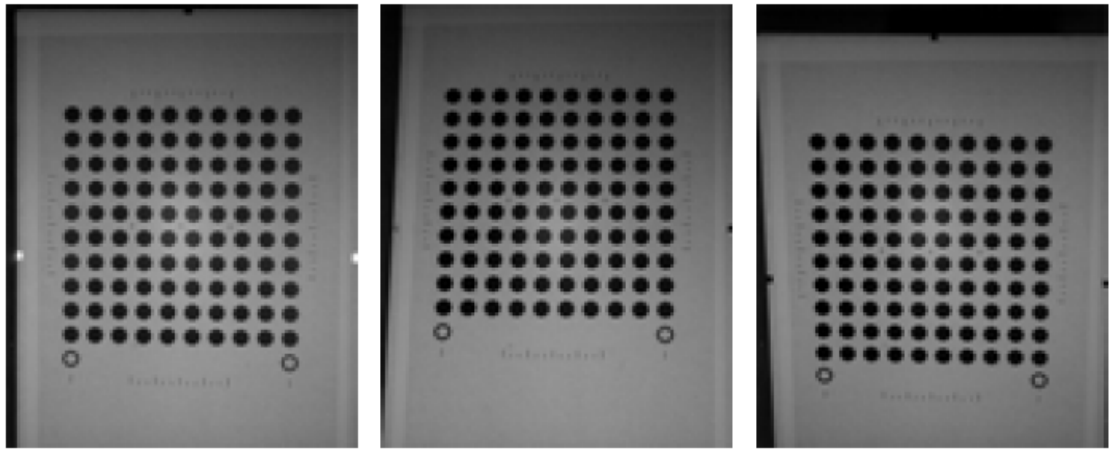
Improved Camera Calibration 1

Innovations:

- Calibration from circular targets: we extract ellipse grid
- We use error model of calibration chart

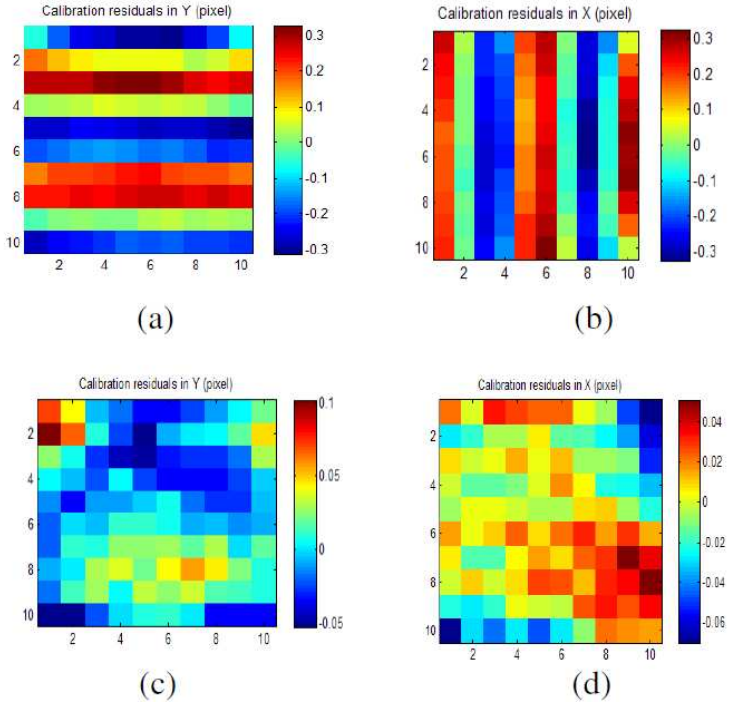
Reduces reprojection error by about 10%

Circular Calibration Chart



Circle subpixel $\frac{1}{100}$ *versus* edge subpixel $\frac{1}{10}$

Improved Residuals



Top: horizontal and vertical residuals with raw calibration chart

Bottom: residuals with calibration chart errors modeled

Sensor Calibration Contributions

New methodologies:

1. RMS *versus* target speed characterisation
2. Stereo temporal noise characterisation
3. Stereo spatial noise characterisation
4. Stereo feature resolvability characterisation

although applied to a specific sensor

Discussion

1. Goal: link 3D data of bat's behaviour during target acquisition: head, ear and nose leaf orientation, mouth opening, head shape to acoustic behaviour
2. Construct HRTF: Head Related Transfer Function for modeling bat acoustic system
3. ChiRoPing EC project: build better robot acoustic sensor
4. 500 FPS sensor + software gives useful 3D data, but needs more extension to get more surface detail + smooth temporal data