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UNIVERSITÄT
TÜBINGEN

Gas Source Tracing With a Mobile Robot Using an Adapted Moth Strategy

Achim Lilienthal, Denis Reimann, Andreas Zell

University of Tübingen, WSI

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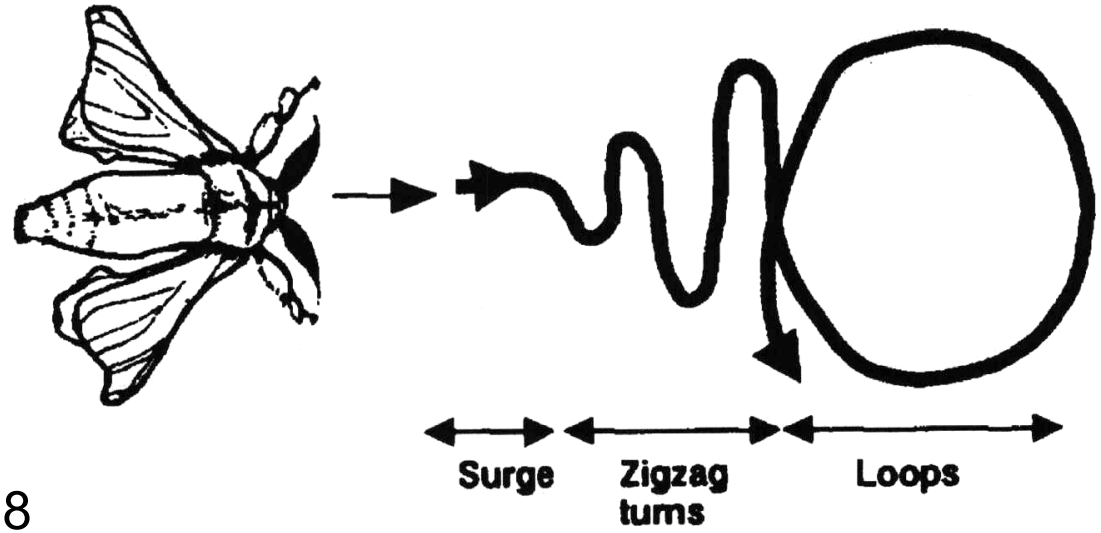
1 Gas Source Tracing of *Bombyx mori*

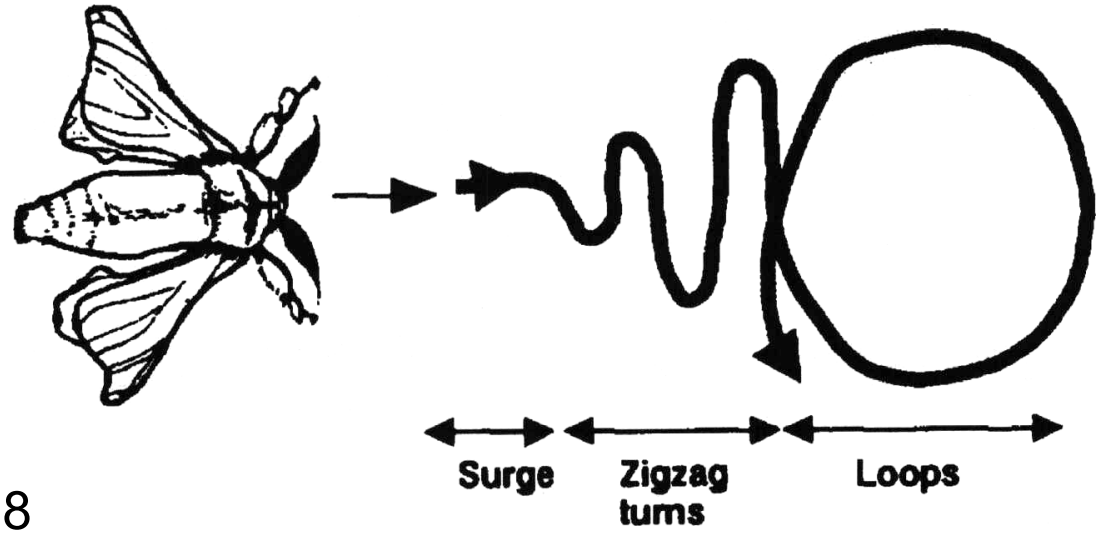
- Fixed Movement Pattern
  - triggered by increased pheromone concentrations
  - surge towards upwind direction



Kanzaki 1998

1 Gas Source Tracing of *Bombyx mori*

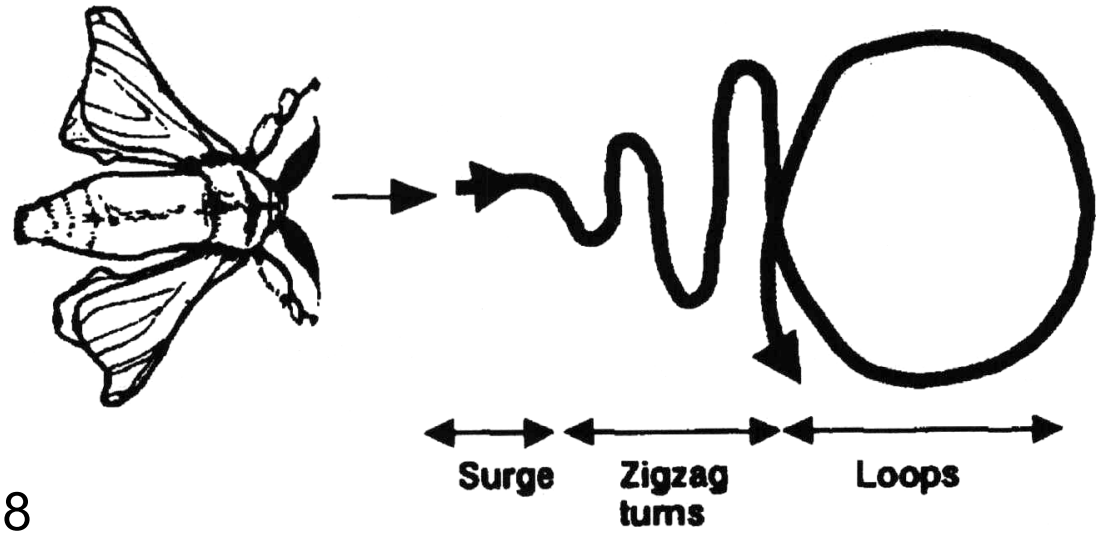
- Fixed Movement Pattern
  - implement a local search for the next patch



Kanzaki 1998

1 Gas Source Tracing of *Bombyx mori*

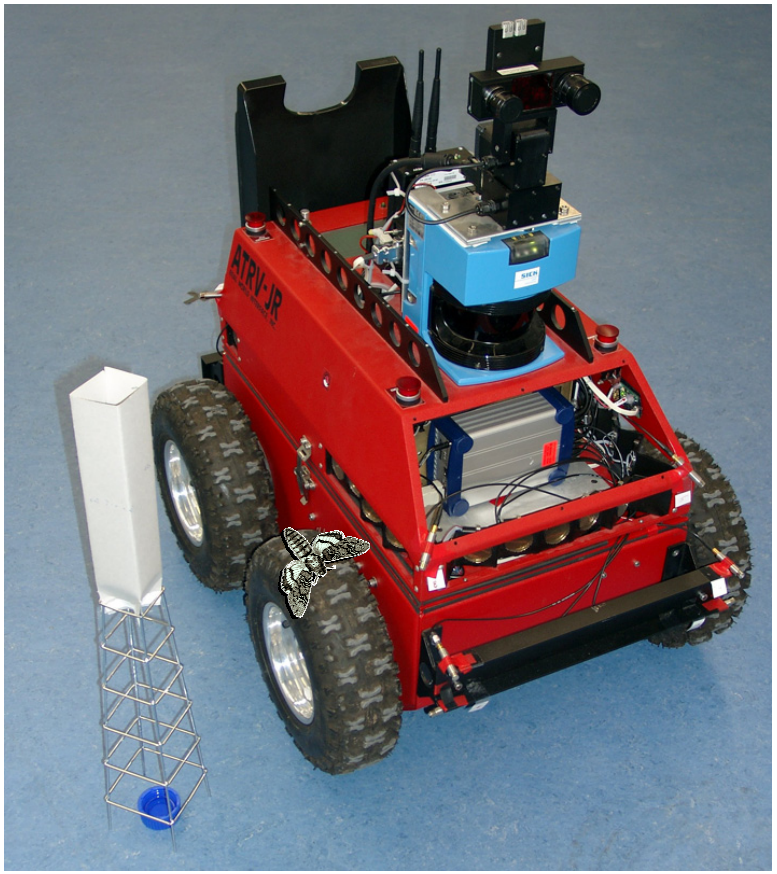
- *“Remarkably, the movement tracks that many species produce when tracking odour plumes have a very similar side-to-side zigzag shape whether walking, swimming, or flying.”* [Mark Willis]



Kanzaki 1998

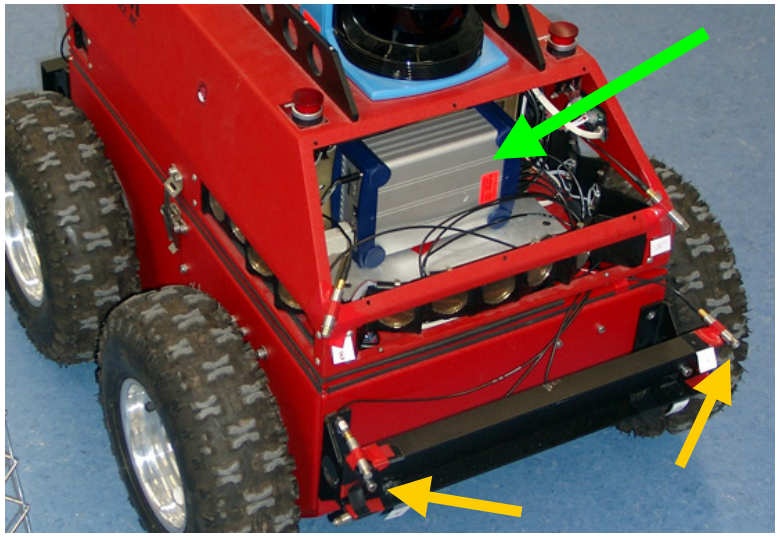
2 Experimental Setup - RoboMoth

- “Arthur” (ATRV-Jr.)
  - footprint = 80 x 65 cm
  - height = 55 cm
- Sensors Used
  - odometry
  - laser range scanner



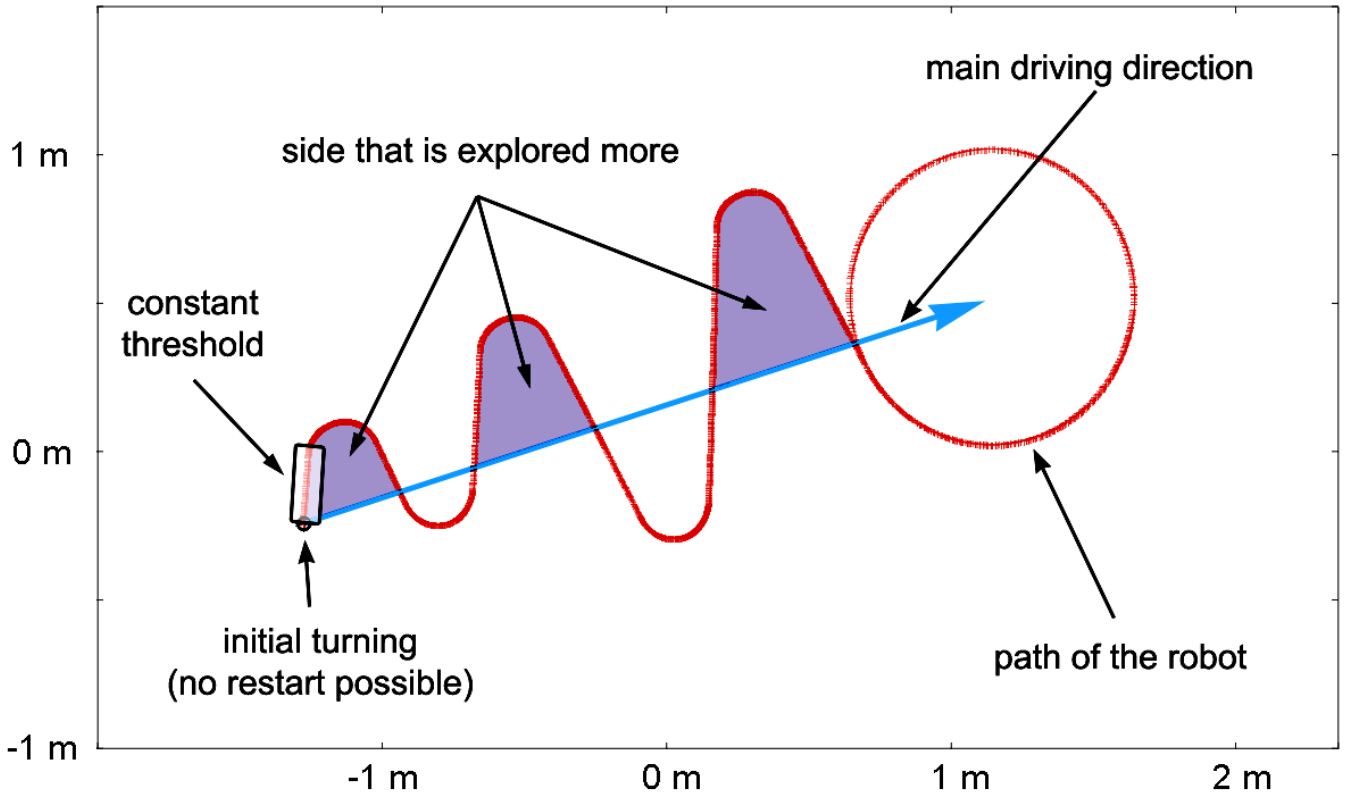
2 Experimental Setup - RoboMoth

- Gas Sensitive System
  - based on VOC-Vario
  - using two TGS 2620



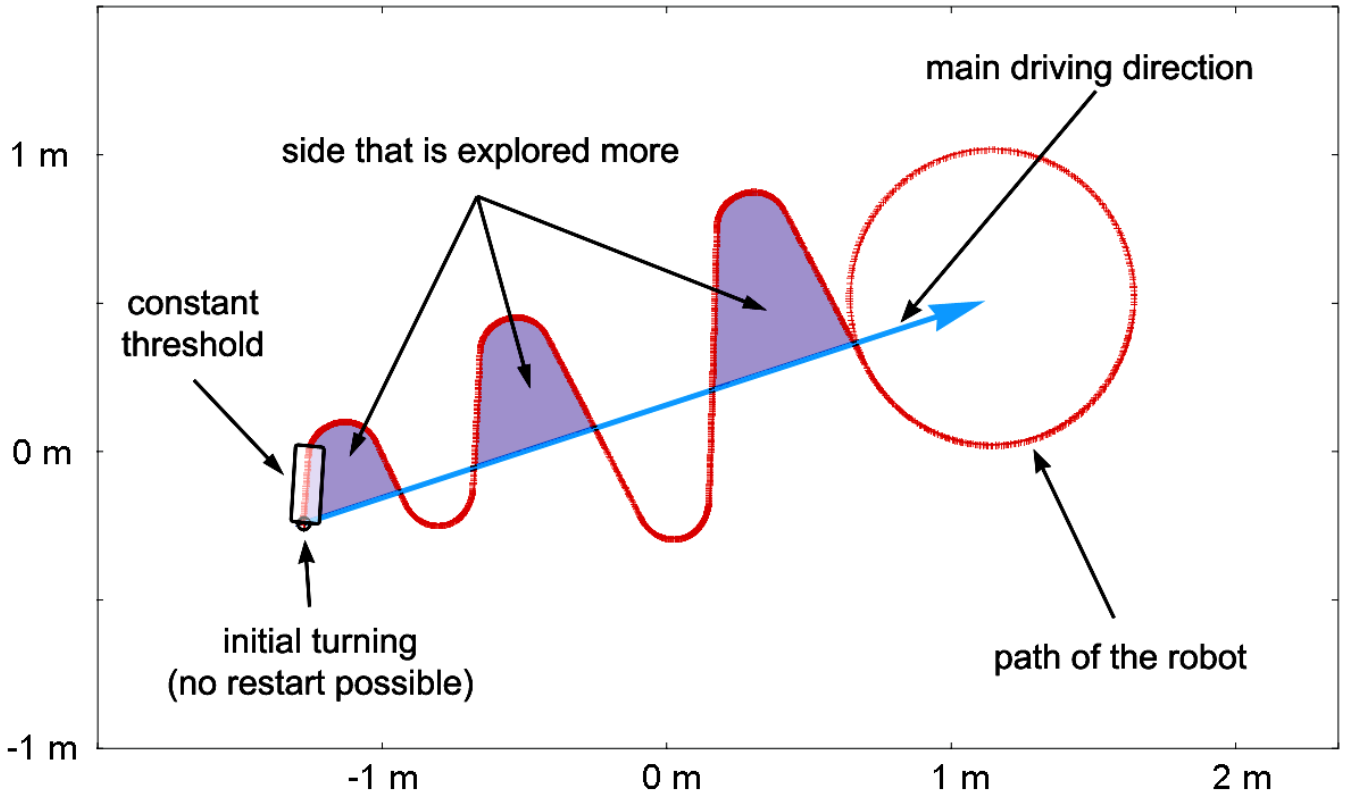
3 Adapted Gas Source Tracing Strategy

- Wind Direction not Known
- Exploit Relative Sensor Response



3 Adapted Gas Source Tracing Strategy

- Adapt Threshold
  (Compensate Slow Response/Recovery)



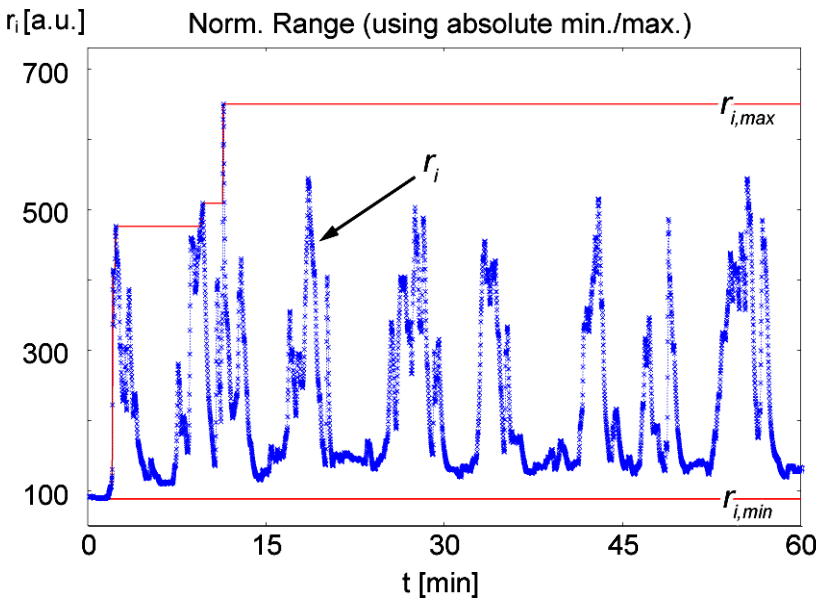
3 Data Preprocessing

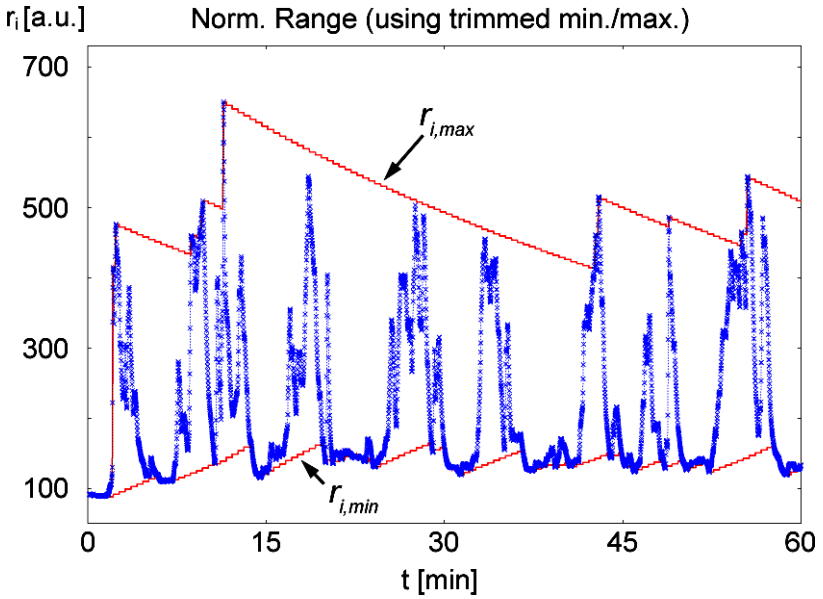
- How to Calculate x ?
  - differences between individual sensors
  - different environmental conditions
  - increasing base level of concentration

$$x_t = \frac{R_t - R_{min,t}}{R_{max,t} - R_{min,t}}$$

3 Data Preprocessing

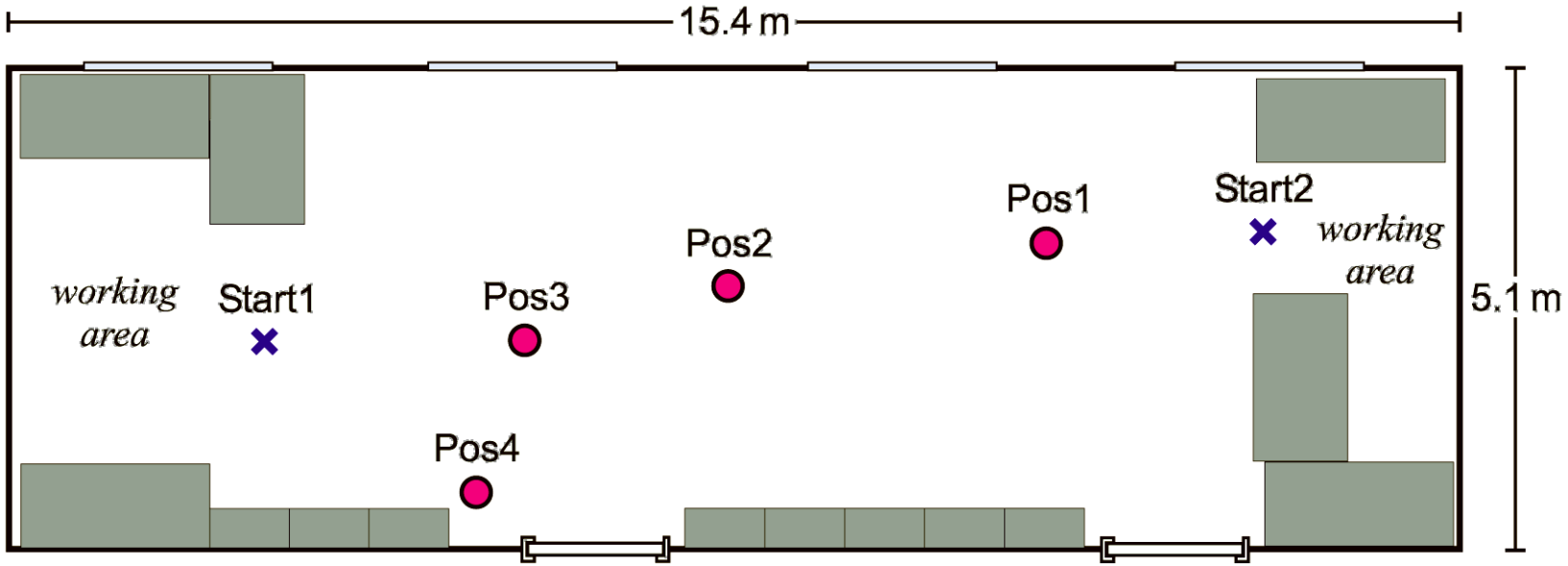
- Update Minimum and Maximum Dynamically
  - trimming by 1% every 30 s





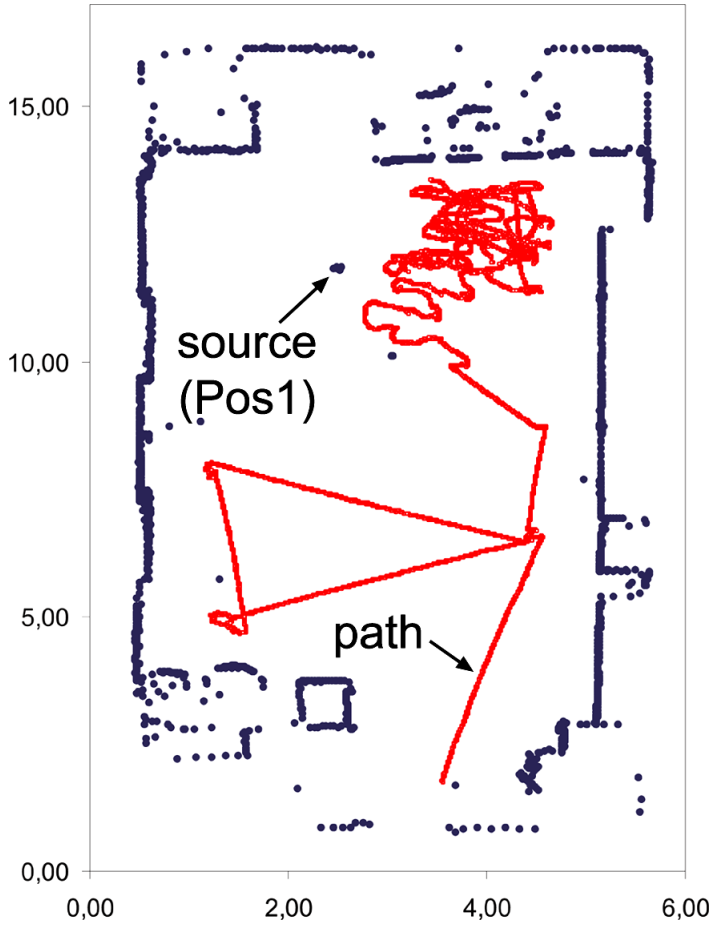
4 Experimental Setup - Environment

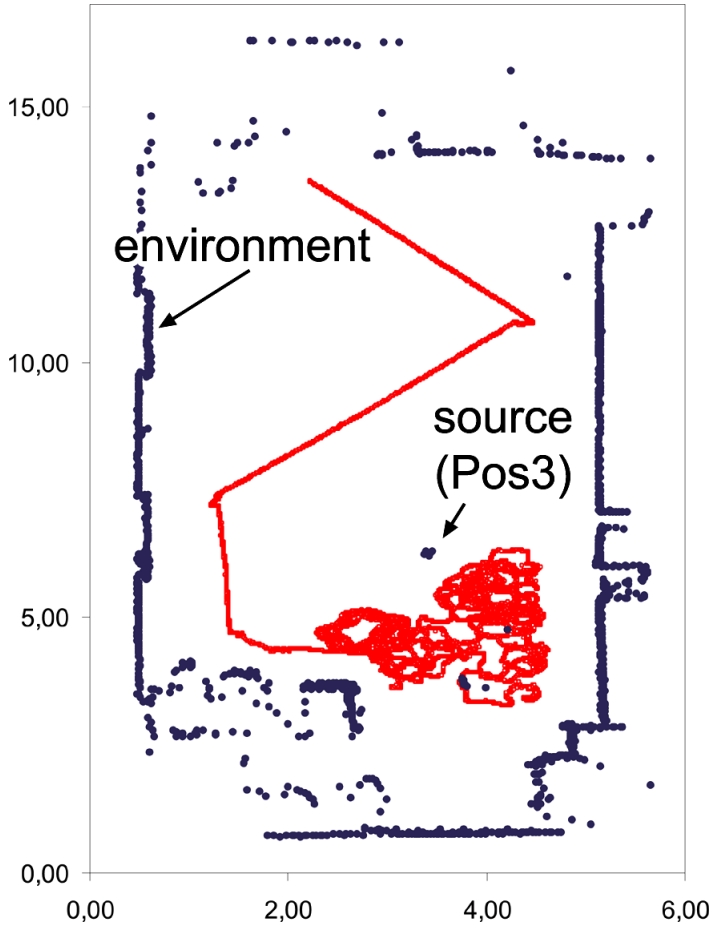
- Office Environment
  - natural indoor environment (to some extent)



5 Results

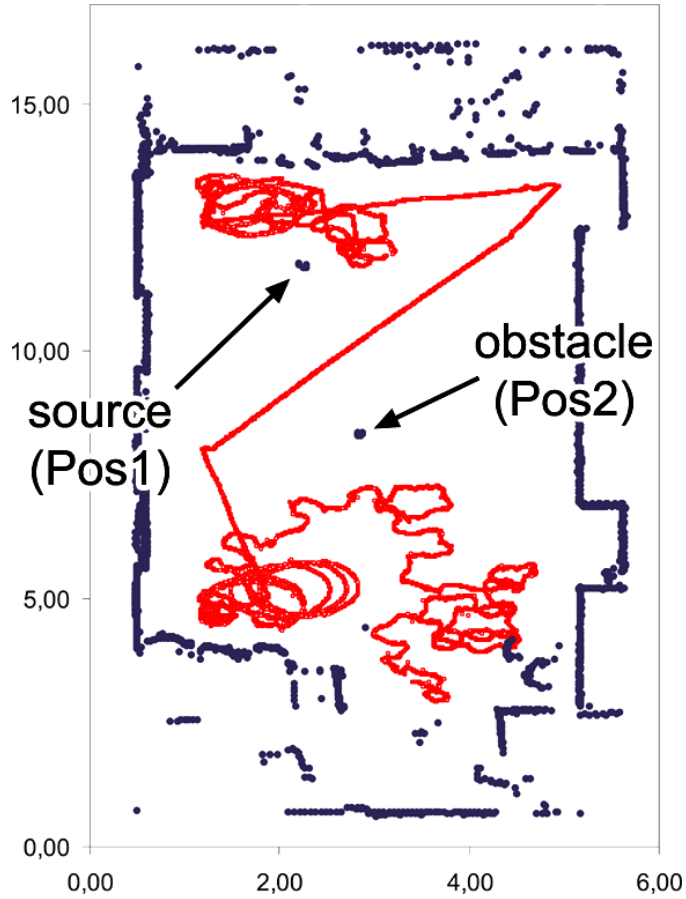
- Active Source Present





5 Results

- Active Source Present



5 Results

- No Active Source Present

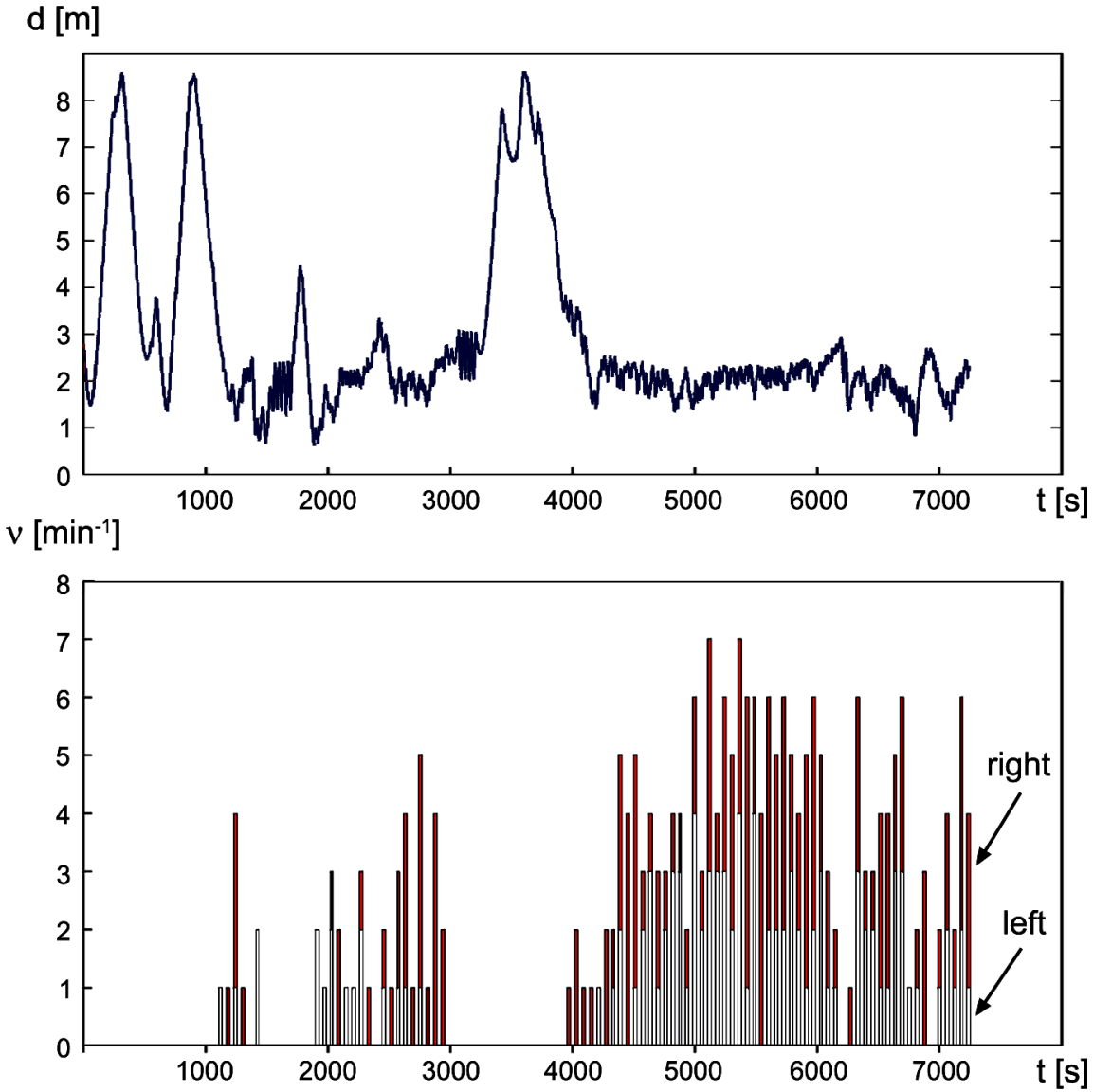
5 Results

- Statistics (595 min)

	average distance	median distance
active source, all	(225.6 ± 179.6) cm	266.2 cm
inactive source	(317.7 ± 235.2) cm	336.8 cm

5 Results

- Statistics
  - after 1. trigger



5 Results

- Statistics (595 min)

	average distance	median distance
active source, all	(225.6 ± 179.6) cm	266.2 cm
active source, after first trigger	(195.5 ± 119.8) cm	170.9 cm
inactive source	(317.7 ± 235.2) cm	336.8 cm

5 Results

- Statistics (595 min)

	average distance	median distance
active source, all	(225.6 ± 179.6) cm	$p_{H_0} = 0.433$
active source, after first trigger	(195.5 ± 119.8) cm	**$p_{H_0} = 0.173$**
inactive source	(317.7 ± 235.2) cm	

5 Results

- Statistics (595 min)

	average distance	median distance
active source, all	$p_{H_0} = 0.167$	266.2 cm
active source, after first trigger	**$p_{H_0} = 0.167$**	170.9 cm
inactive source		336.8 cm

6 Summary & Outlook

- Adapted Biomimetic Strategy (*Bombyx mori*)
  - local search (fixed motion pattern)
  - triggering mechanism
- Suitability for Indoor Gas Source Tracing
  - good evidence
- More Experiments needed
- Larger Environment

WSI
Wilhelm-Schickard-Institute for Computer Science

Eberhard Karls
Universität
Tübingen

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Thank you!