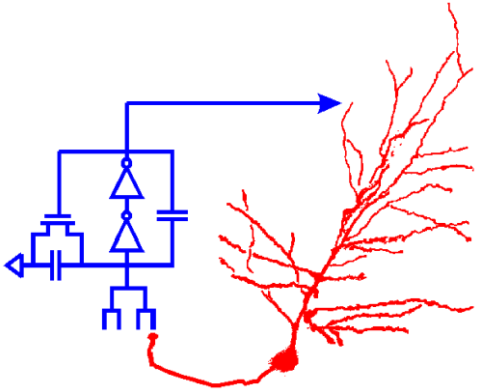
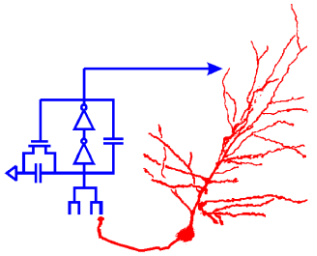


Object Tracking and Selective Attention in a Bat-Inspired Echolocation System

Sairina Mirchandani and Stephanie Doctor

Mentor: Dr. Timothy Horiuchi

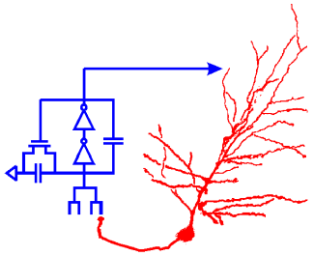
Motivation



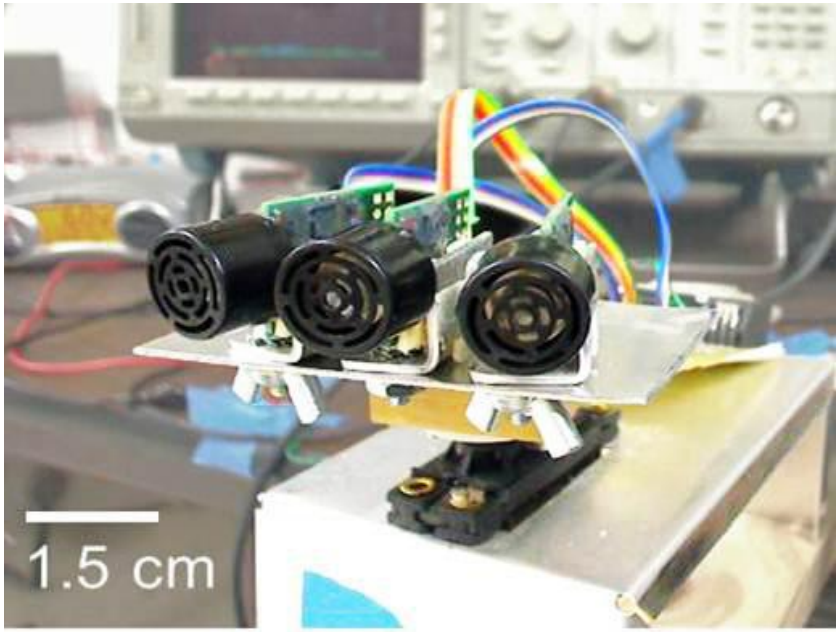
- Bats' echolocating abilities coveted for man-made flying agents
- Typical air-coupled sonar devices cannot precisely locate an object

Bill Bat Boy Enterprises Inc. © 2008

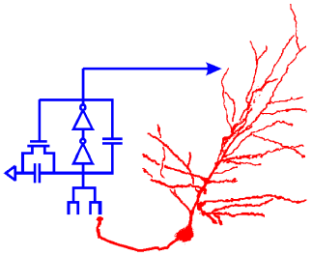
Setup

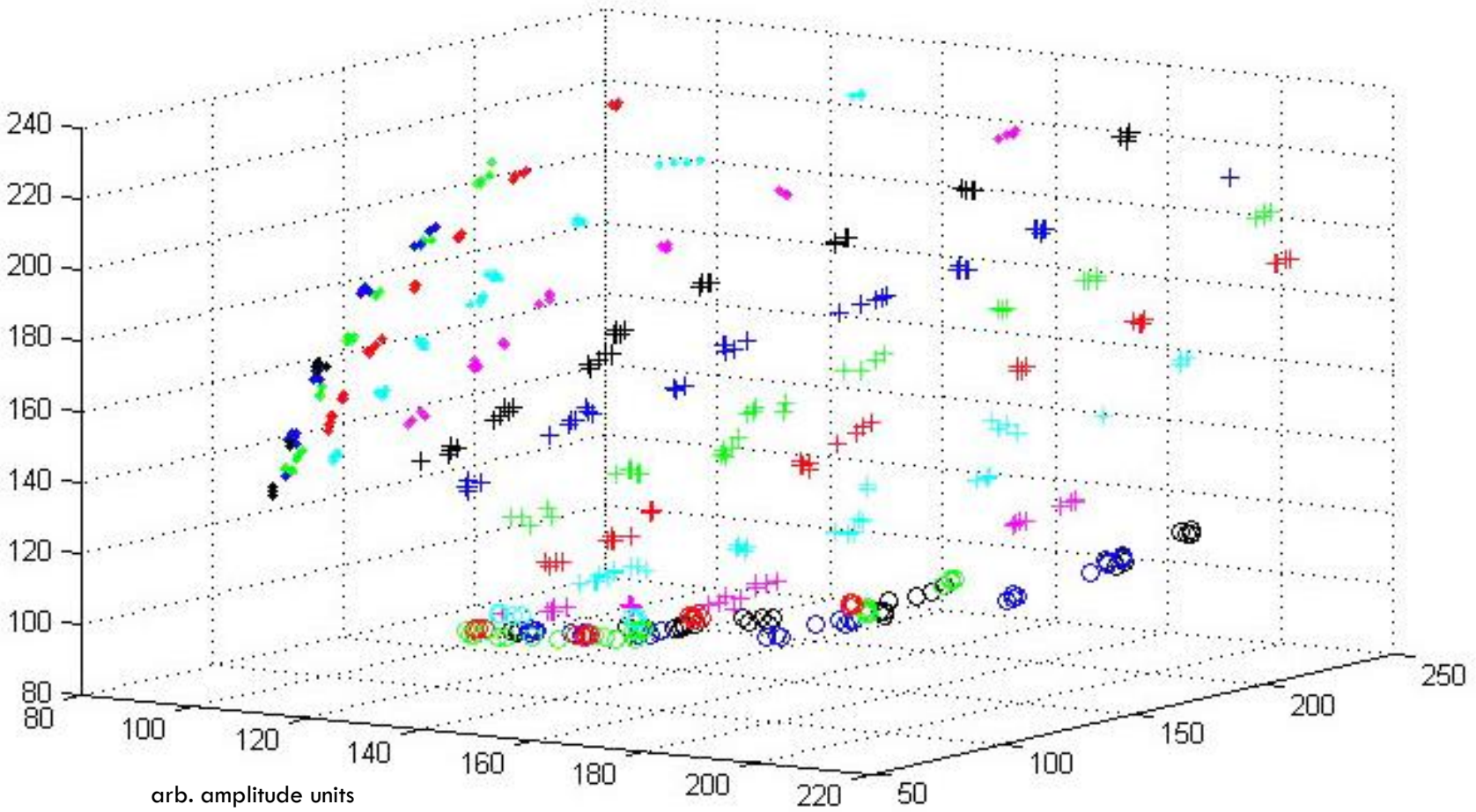


- 3 sonar transducers, 40 kHz
- Mounted on rotational head controlled by computer through Pololu® servo

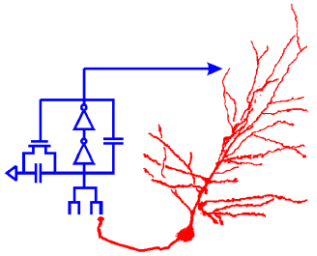


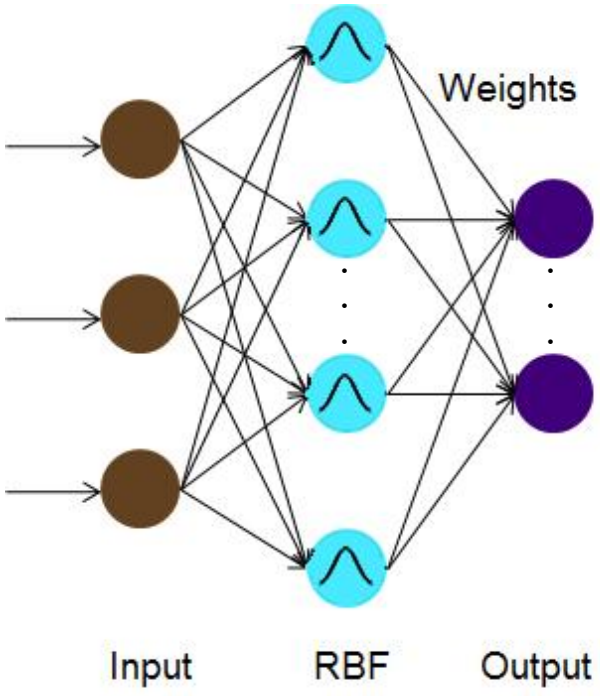
Pinger Data

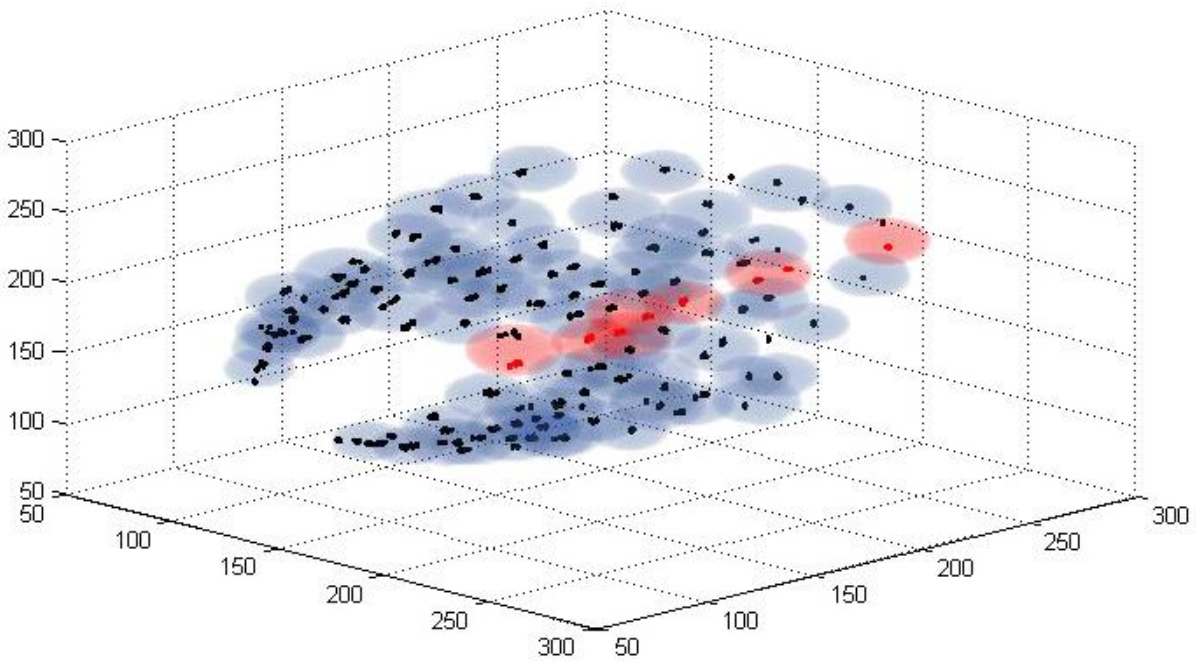



240
220
200
180
160
140
120
100
80
80
100
120
140
160
180
200
220
50
100
150
200
250
arb. amplitude units

Radial Basis Function Learning

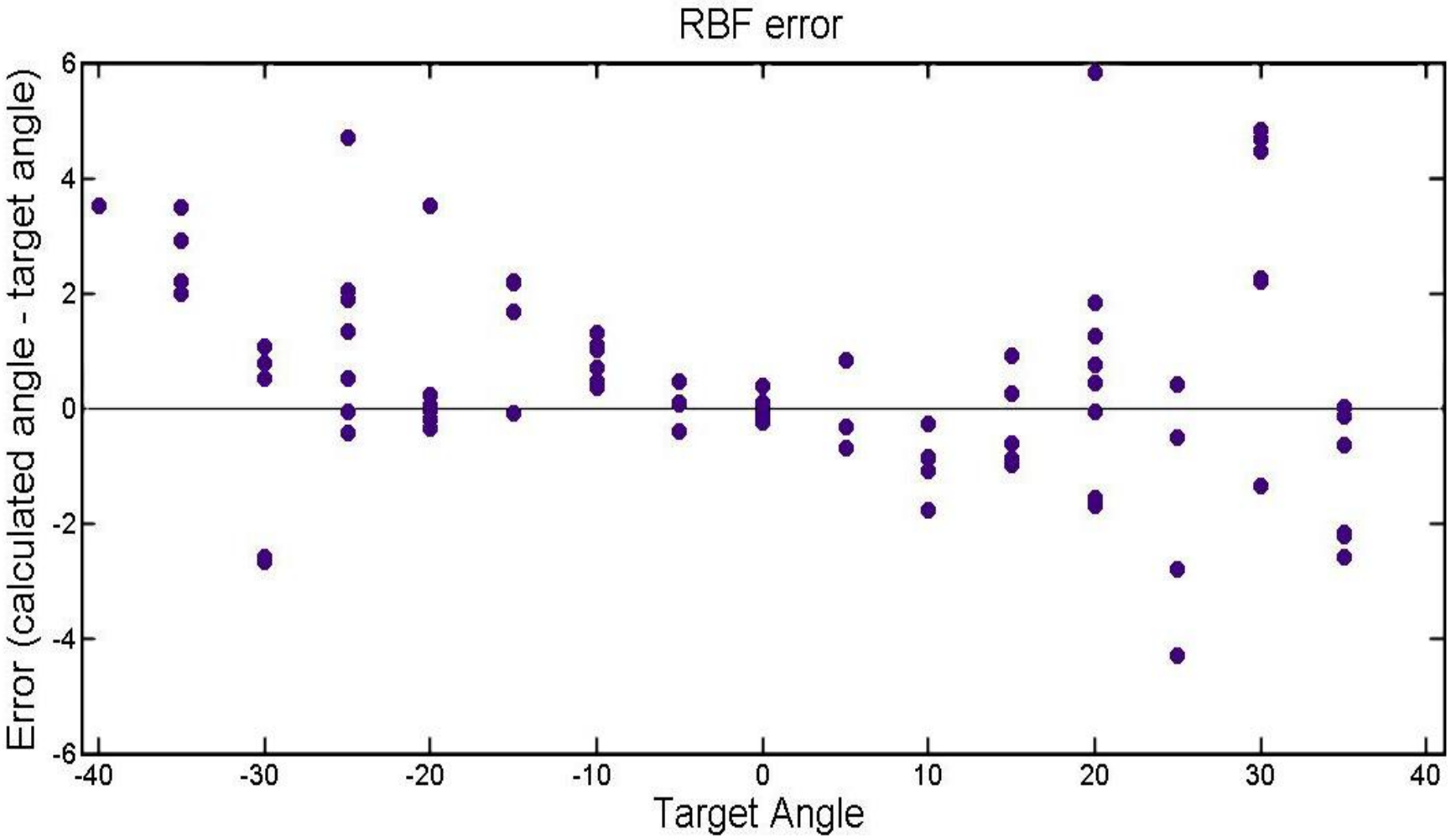




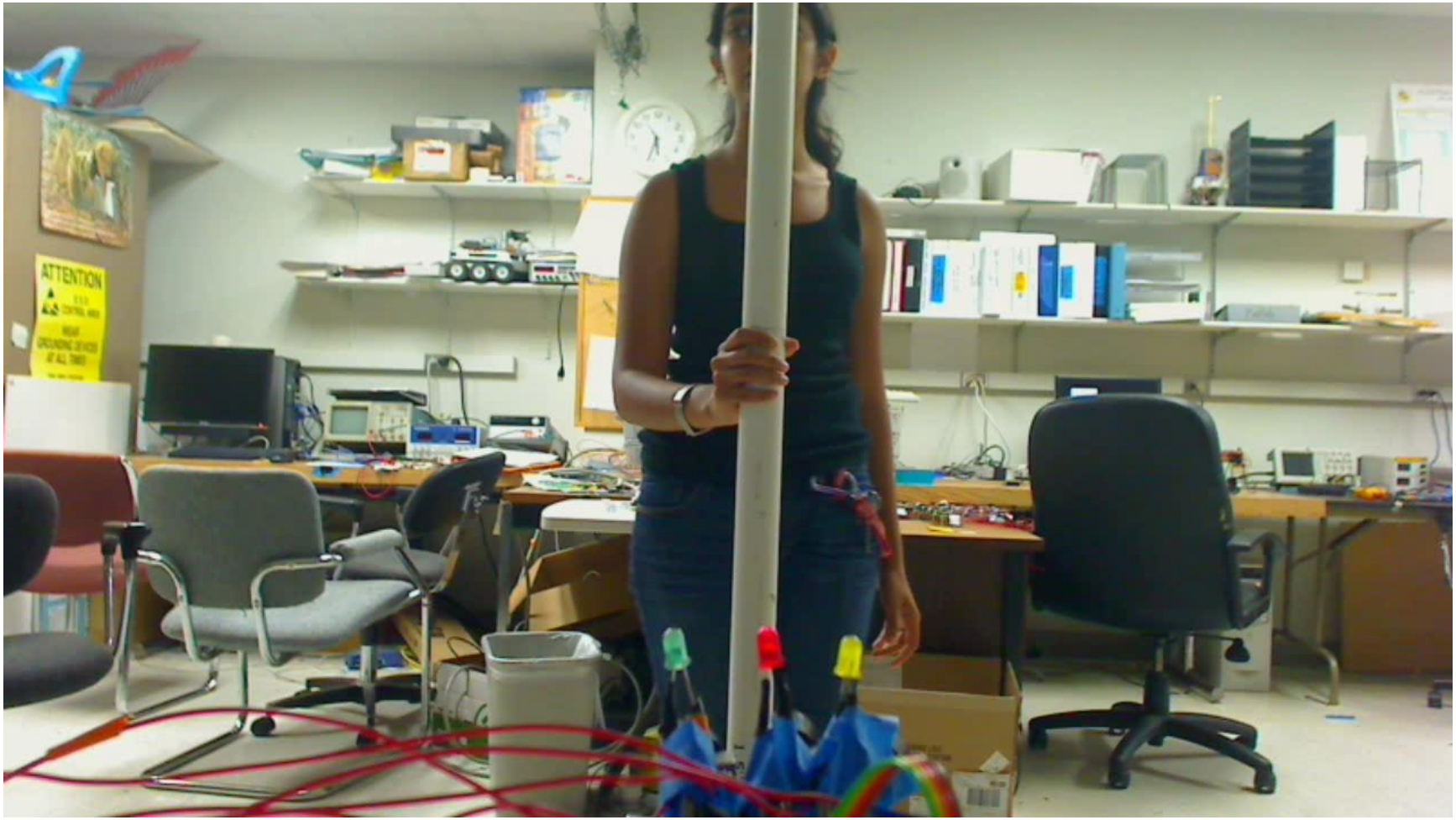


Cloud size=1 standard deviation

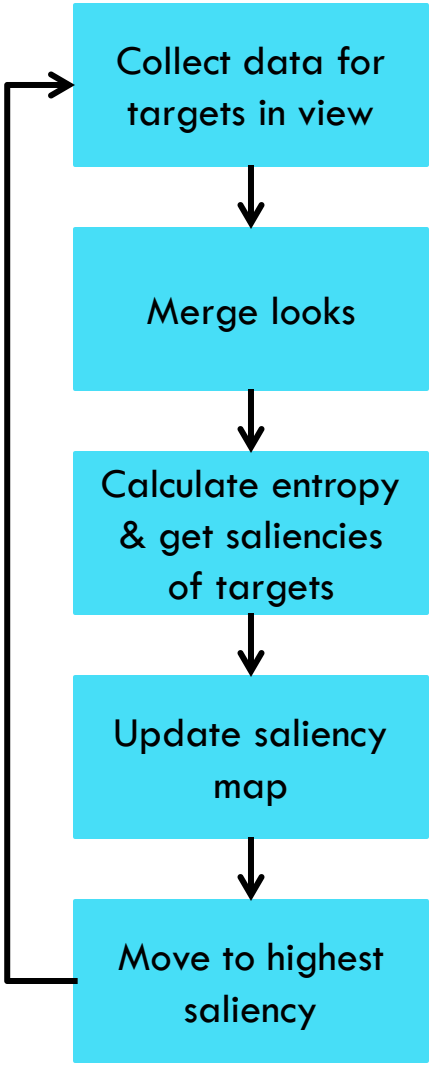
System Performance



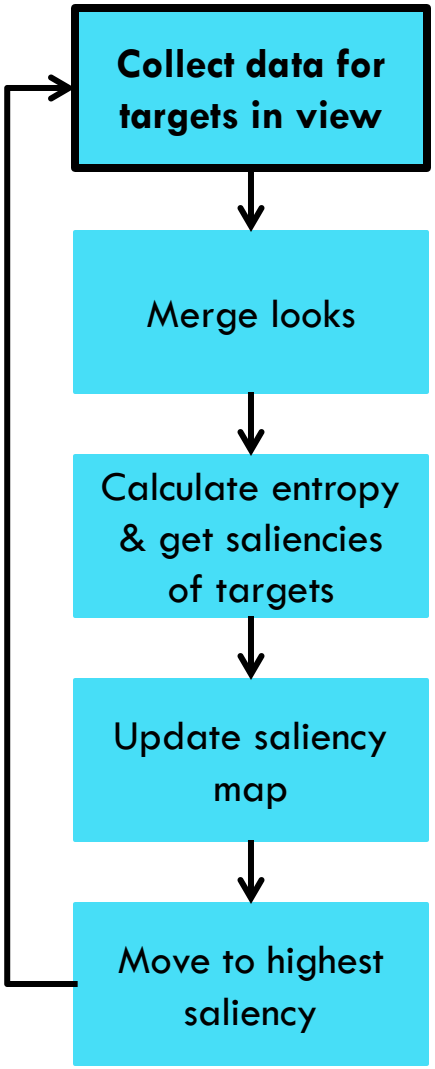
Tracking a Target



Attention


Collect data for targets in view
Merge looks
Calculate entropy & get saliencies of targets
Update saliency map
Move to highest saliency

Attention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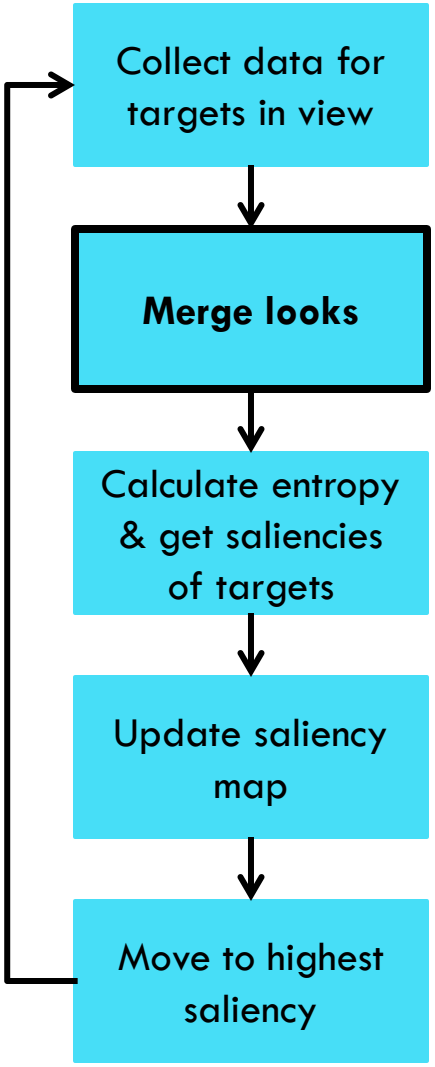
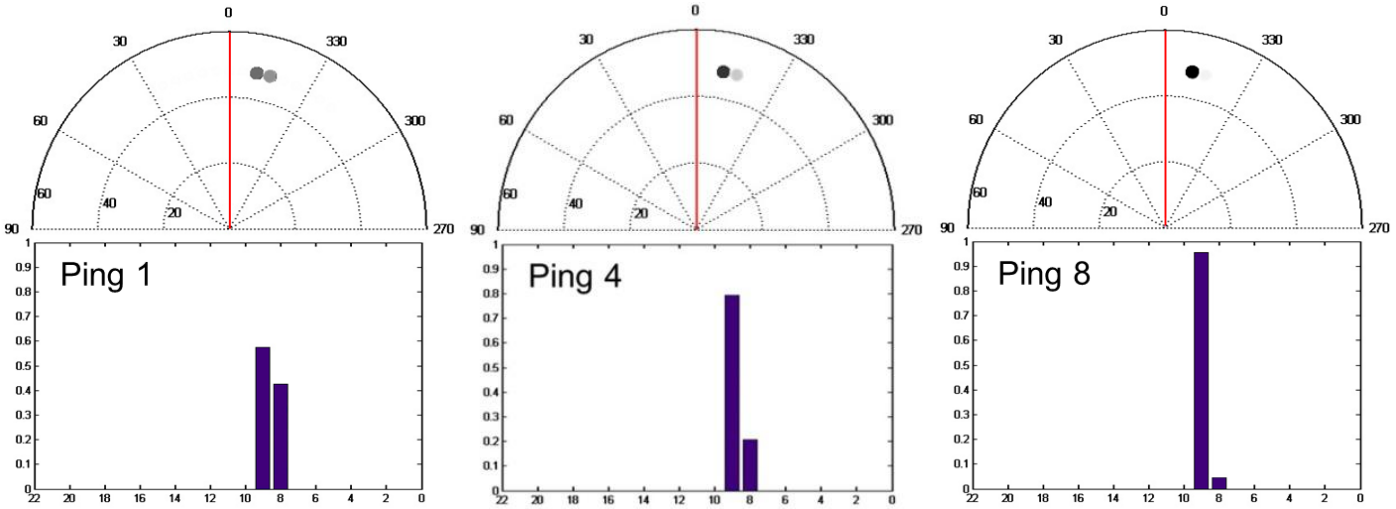
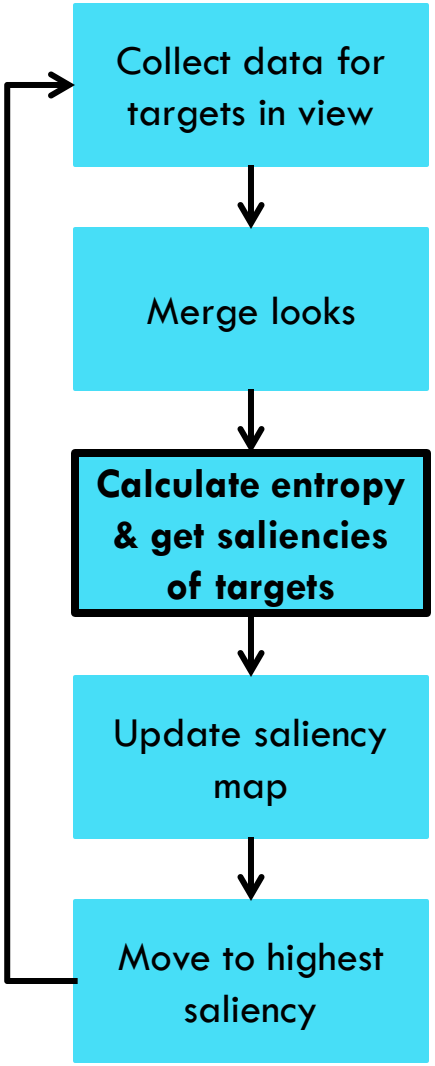
Attention



- If an object is seen again its certainty should go up
- Multiply and renormalize the output distributions

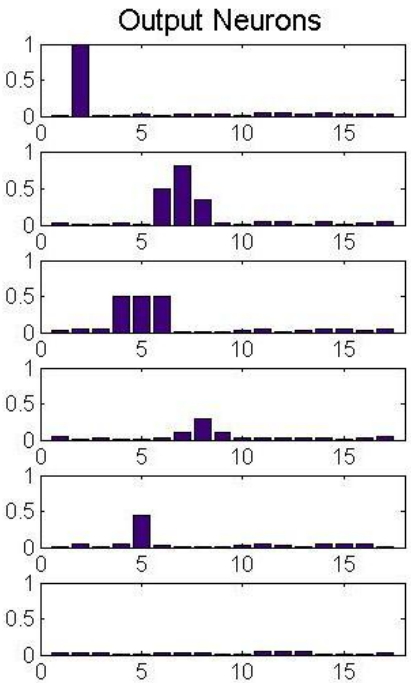


Attention



$$\text{Entropy} = -\sum p(x)\log p(x) \quad (1)$$

$$\text{Saliency}(x) = \text{Entropy} \times p(x)$$



Entropy

2.88e-16

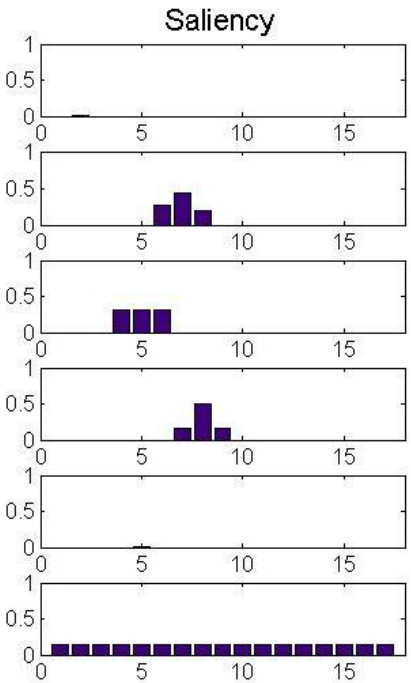
0.4524

0.47712

0.4127

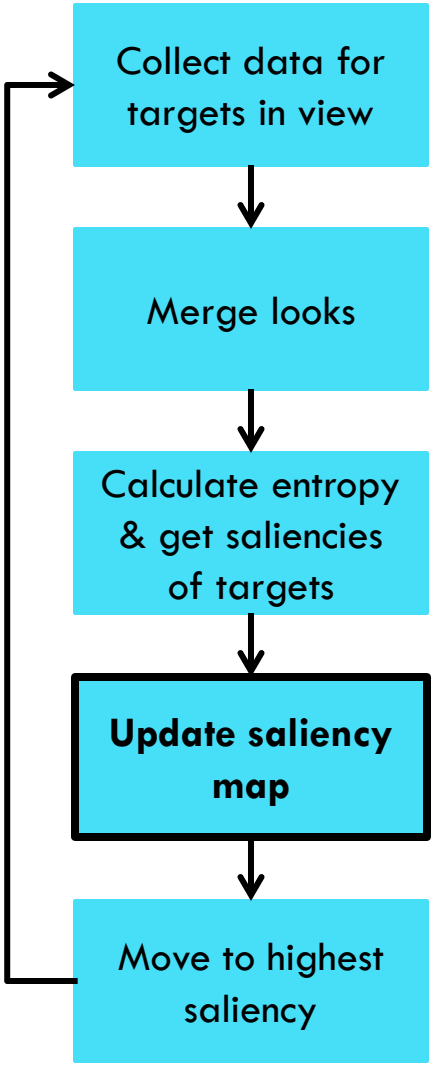
6.2767e-16

1.2304



(1) Renninger, Verghese, & Coughlan (2007). *J. Vision* 7(3):6, 1-17.

Attention


Collect data for targets in view
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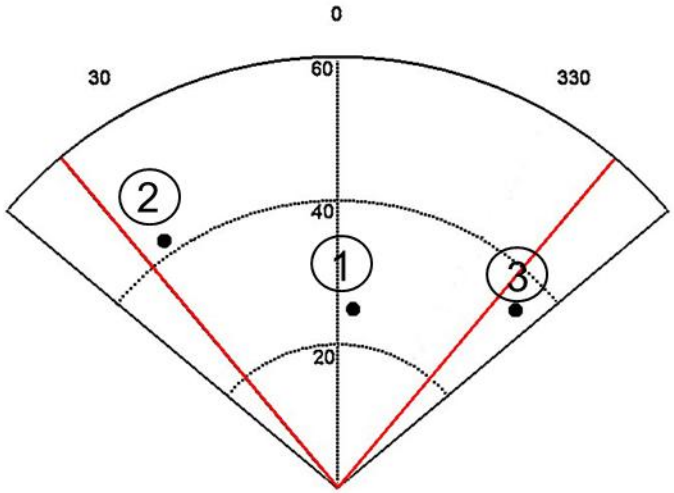
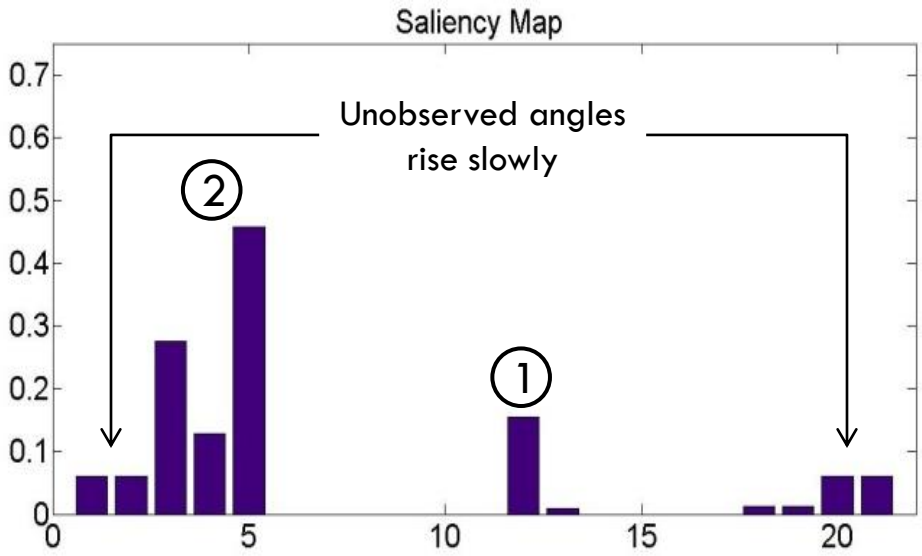
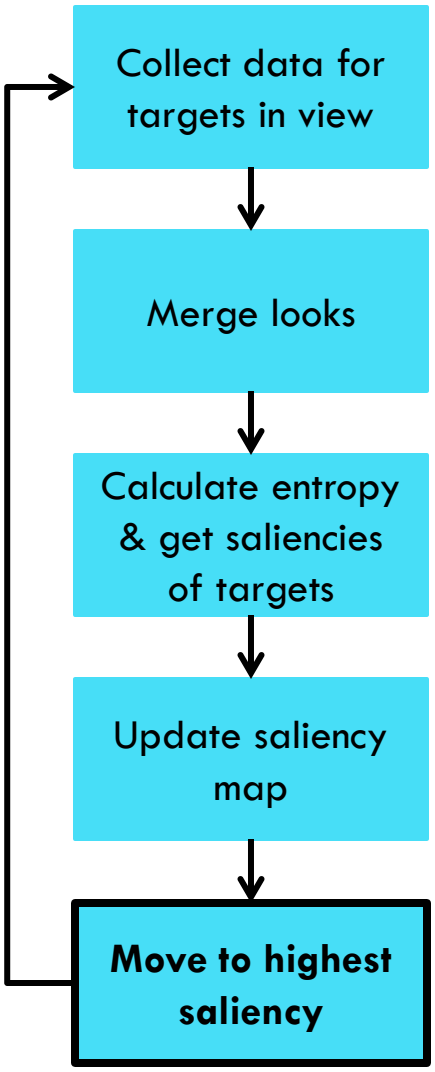
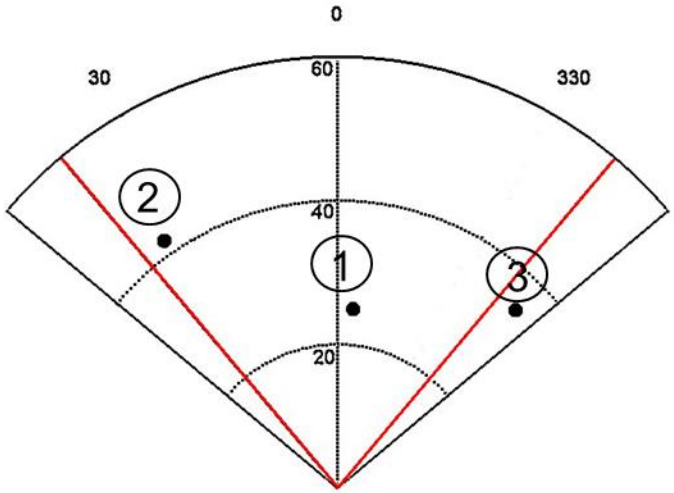
Move to highest saliency

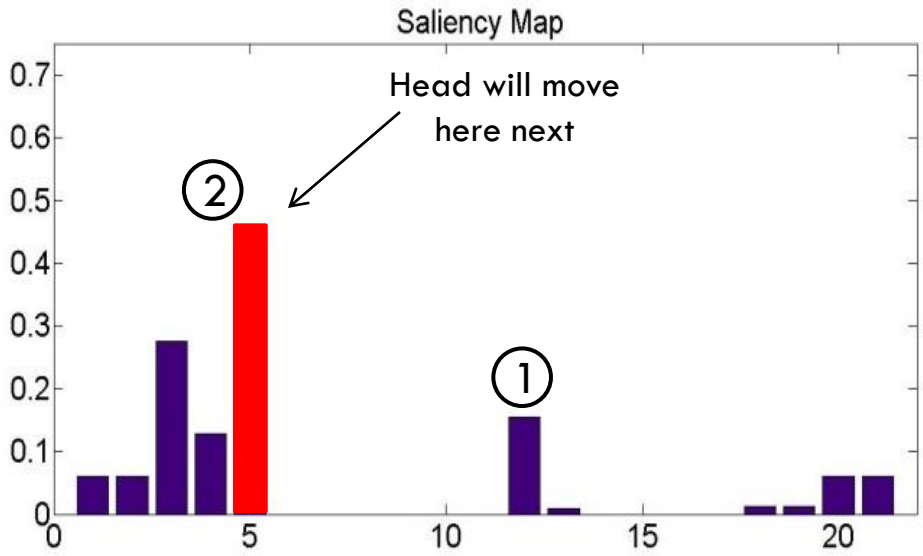

0
30
60
330
40
20
1
2
3


Saliency Map
Unobserved angles rise slowly
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
1
2

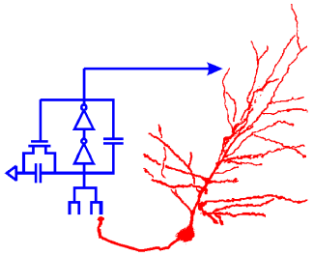
Attention


Collect data for targets in view
Merge looks
Calculate entropy & get saliencies of targets
Update saliency map
Move to highest saliency


0
30
60
330
40
20
1
2
3


Saliency Map
Head will move here next
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
1
2

Conclusion



- A biological approach is beneficial
- System achieved resolution of 5° (error = ±6°)

http://www.bu.edu/cecb/bats/bat-facts-and-folklore/

Acknowledgments

- National Science Foundation OCI award #1063035
- Tarek Massoud
- Dr. Cynthia Moss