Spatial and temporal limits of pattern motion analysis by MT neurons

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Direction selective (DS)

Component direction selective (CDS)

Pattern direction selective (PDS)

Measured response
CDS prediction

Adapted from Movshon, Adelson, Gizzi & Newsome, 1985
Majaj, Carandini, and Movshon, 2007

Small gratings

Small plaid

Pseudoplaids

Measured response
CDS prediction

Majaj, Carandini, and Movshon, 2007
<table>
<thead>
<tr>
<th>Number of patches</th>
<th>Visual schematic</th>
<th>Patch size (fraction of RF size)</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td><img src="image" alt="Visual schematic 4" /></td>
<td>1/4</td>
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<tr>
<td>16</td>
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CDS prediction

Measured response

PDS prediction

16 patches

4 patches

True plaid

60 ips

60 ips

60 ips

- Measured response
- PDS prediction
- CDS prediction
Z-correlation (pattern)

True plaid

16 patches

4 patches

Z-correlation (component)

Pattern Index

Patch size (fraction of RF size)
Spatially filtered motion signal

Spatially overlapped motion signal

Spatial filter

4 patches

16 patches
$\sigma = 0.025$

**Diagram Description**

- **Pattern index (true plaid)**
  - $\sigma$ (fraction of RF size)
  - $n=57$

- **Patch size (fraction of RF size)**
  - $\frac{1}{36}, \frac{1}{16}, \frac{1}{4}$
Grating 1
Grating 2

On
Off

Frame number

1
32

Visual schematic

Alternation period @ 120 Hz

133.3 ms

33.3 ms

0 ms
0 ms (True plaid)

Z-correlation (pattern)

n=93

Pattern

Component

33.3 ms

Z-correlation (component)

133.3 ms

Alternation period (ms)

Pattern index
**Rapid alternation**

- Grating 1
- Grating 2
- Temporally overlapped motion signal
- Temporally filtered motion signal
- Temporal filter

**Slow alternation**

- Grating 1
- Grating 2
- Temporally overlapped motion signal
- Temporally filtered motion signal
- Temporal filter

\[ \tau \]
Component

Pattern

$n=93$

$\tau = 16.8 \text{ ms}$

Alternation period (ms)

Pattern index (true plaid)

$\tau (\text{ms})$

Pattern index

Graph showing the relationship between alternation period and pattern index.
Conclusions

The spatial and temporal scales over which MT neurons compute pattern motion are small and brief.

We quantified these limits using simple spatial and temporal filter models. The median spatial filter had a characteristic scale of 5% of the RF size. The median temporal filter had a time constant of 8 ms.

These parameters can be used to constrain current models of how pattern motion is computed in MT.
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