Experience-dependent Active Vision in an Autonomous Quadruped Robot

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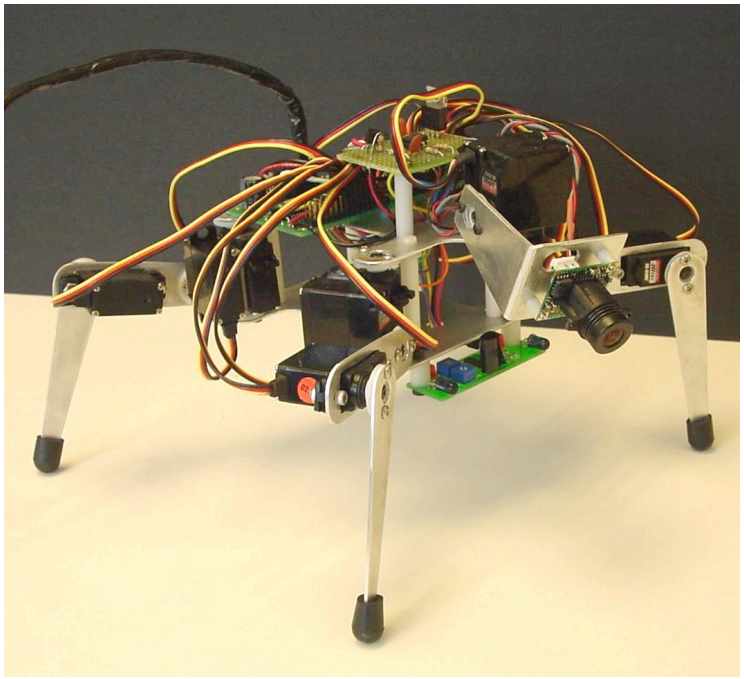
Goals

- Model bottom-up process of visual attention.
- Incorporate visual attention into a neural model for learning appetitive and aversive objects.
- Develop theories on how neuroplasticity, behavior, and visual attention interact affect learning.

Hypthothesis

- Active vision is a plausible method for value learning in robots and thus primates.

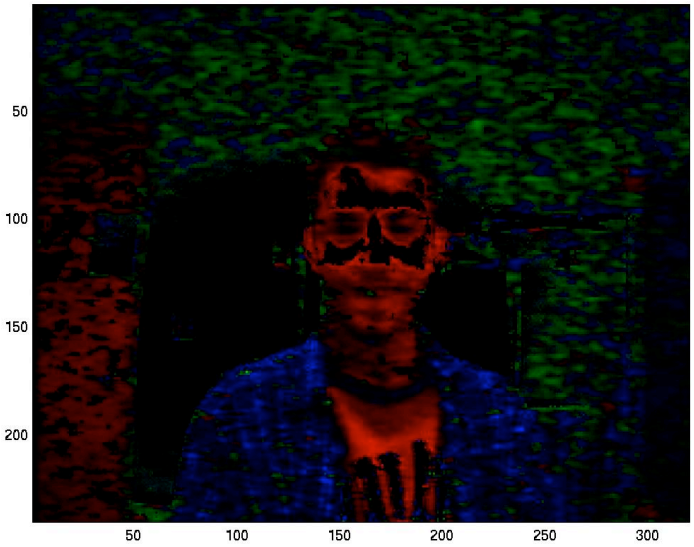
Platform for Attention



Strider is a quadruped with a color CCD camera that has two degrees of freedom. The robot is tethered to a computer where all image processing is done in Matlab

Strider's Bottom-Up

Color Feature Map



- Opponent-Colors

$r` = r_n - (g_n + b_n) / 2$

$g` = g_n - (r_n + b_n) / 2$

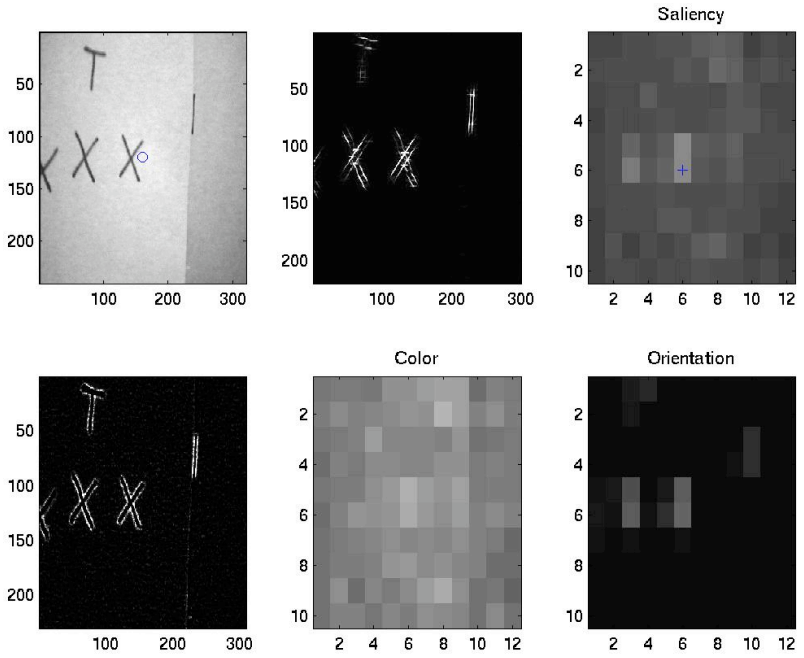
$b` = b_n - (r_n + g_n) / 2$

$y` = (r_n + g_n) / 2 - b_n - ||r_n - b_n||$

Strider's Bottom-Up

Feature Maps & Saliency Map

Images undergo their respective filter and then are fit to 10x12 grayscale feature maps. The saliency map is created by adding the weighted values of each feature map.



Behavior: Tasting

- As Strider approaches an object, gait becomes smaller yielding cautious behavior.
- By positioning its head directly down, Strider indicates that it has tasted salient object.

Neuromodulation

- Strider's model for learning involves the use of catecholamines.
- Dopamine is theorized to play an important role in learning, specifically the time during learning at which dopamine is released.
- Strider's model is an abstraction of the midbrain neuronal cluster.

Neuromodulation

- Approaching an object for the first time, Strider `tastes' and associates the features of the object with either an appetitive or aversive object (if dopamine is released at the appropriate interval).
- Subsequent trials yield that learning has taken place when, simply upon seeing a salient object, Strider classifies the object as appetitive or aversive and behaves.

Three Experiments

- **Experiment 1:** Disable quadruped walking, simply show Strider a color

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- **Experiment 3:** Enable reward system, when rewarded for red values change (behavior affects learning)

Results

- **Experiment 1:** Saliency is favoured
- **Experiment 2:** Again, favoured
- **Experiment 3:** When approaches favoured object, value for that object increases and others decrease. Eventually only approaches the appetitive object.

Summary

- Saliency is a model for instantaneously determining interesting objects in a scene.
- Strider incorporates a biologically-based model for walking and visual attention using saliency.
- Strider shows that behavior affects plasticity of its learning mechanism, in this case value learning.

The End