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CSCI 5822 - Probabilistic Models
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A Review of: Motion Illusions as Optimal Percepts

Motion illusions as optimal percepts is focused on showing that the optical illusions that are often seen by humans aren't necessarily a flaw in our visual or temporal systems, but instead a natural occurrence in a system that isn't perfect, but attempts to provide an accurate enough description of what is happening before the observer's eyes. They begin by giving a ground-level description of motion perception. The problem wanting to be solved is that of estimating how human perception works through mathematical analysis. They explain the various estimation techniques typically used, as well as the relevant stimulus features. They walk through how the given techniques predict motion in various scenarios, as well as how human perceptions compare (including explanations using the relevant stimulus features).

They then delve into using Bayes' rule (and estimation theory in general) in creating an "ideal observer," which is intended to simulate the ideal performance (note that this does not equate to perfect performance, but more so directed toward the upper limit of human estimation in a situation that involves some degree of uncertainty). They then note two key assumptions and how each is dealt with. First, local image measurements are noisy (dealt with by using a common noise model that, while imperfect for this task, is good enough to be sound for most of the data). Second, image velocities are typically slow, which correlates strongly to human perception (dealt with by using a Gaussian prior distribution about that origin, thus leaning toward zero velocity in the absence of image data, and toward lower velocities in general).

Once they present their matrix equation for the ideal observer, they review their results. For single gratings, lower-contrast patterns were estimated to have slower velocities than their higher-contrast relatives. They relate this to a possible explanation of automobile velocity increases present in lower-visibility conditions such as fog. It was also explained the velocity estimation is strongly relative, in that absolute contrast doesn't matter nearly as much as contrast relative to another grating. The ideal observer matched these predictions. Similar predictions (both human and ideal observer) followed for plaids.

They go into detail about the distinctions between the two types of plaids and how they affect movement perception, and conclude with discussion surrounding their results, with comparisons to popular approaches to the problem. It is stated that, while their approach isn't perfect in its predictions, it does match a wide range of human percepts and offers opportunities for future experiments and possible extensions to their work.

Interesting:

- They chose to use an imperfect observer for comparisons to their model
- They had a really cool way of dealing with their two key assumptions (using a Gaussian prior distribution to deal with slower velocity trends is a super interesting idea to me)

Questions:

- What applications could these findings have to computer vision systems such as self-driving vehicles, as well as to fields such as evolutionary biology?