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Understanding visual salience can improve 3D seismic interpretation software design

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As the mountain of seismic data continues to grow with both new and legacy material requiring processing, seismic interpreters face an escalating challenge to turn large amounts of data into discoveries and improved reservoir performance. As a result, the demand for computational tools to underpin the 3D seismic interpretation process has never been more apparent. To fully exploit the data and improve productivity, 3D seismic interpretation software needs to exploit the cabilities of the human visual system.

Advances in visual science have lead to quantitative models of some aspects of visual perception, visual clustering and perceptual grouping. We believe that consideration of these models in the software development process is important if we are to design more effective and efficient interpretation processes and workflows. Such processes and workflows need to be good socially (Does the software fit into the interpreter’s workflow?), cognitively (Can the interpreter easily understand the stages of the workflow?) and, perhaps most importantly, perceptually (Can the interpreter easily interpret the visual information?) [2].

Here we concentrate on the human perceptual system and its effect on interpreting seismic data. Perception is a neurological process as humans gather information from the world around them using sensory receptors, such as their eyes, and interpret this information largely based on memory. As memory influences the interpretation of visual information, knowledge, experience, cultural background and social background all affect an individual’s perception [3].

When presented with an image, for example a seismic data set, the interpretation of the image starts with a quick scan of the scene to identify areas of interest. Often this is an unconscious process. From an evolutionary perspective it was important for complex biological systems such as ours, to be able to rapidly detect potential prey or predators amongst a visually cluttered world. However, despite the complexity of our visual processing we cannot simultaneously identify all the targets in one's visual field [4]. Complex object recognition is based on processing objects or areas of interest sequentially and there is a tendency to focus on areas in order of their visual salience.

An example of how our attention is drawn to an anomalous item that is surrounded by an array of distracting items can be seen in Figure 1. In Figure 1a, the anomalous item has a high visual salience as attention is immediately drawn to it. Similarly, in Figure 1b the vertical bar attracts attention; this suggests that visual salience is determined by considering an item within its surrounding context. In the third example (Figure 1c), there is again one bar that is different to the rest, however with little salience to guide you towards it, you are required to work harder by manually scanning the image, to find something anomalous.

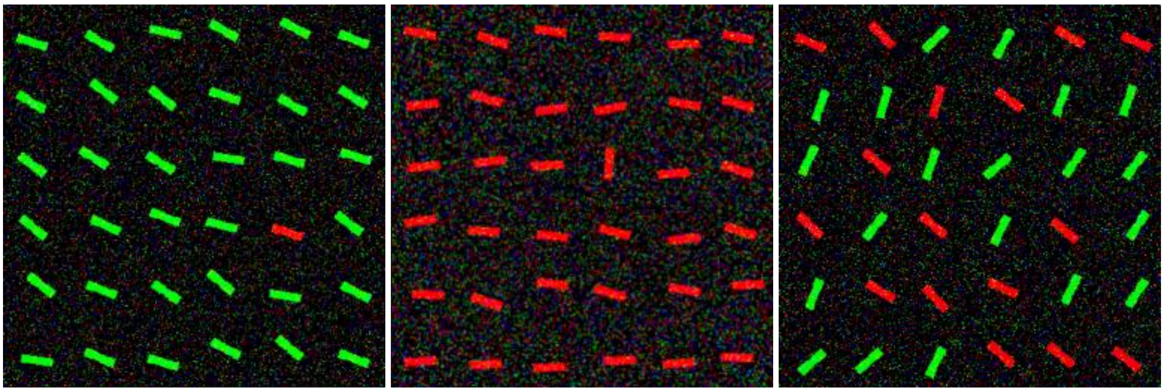

Figure 1 a Figure 1b Figure 1c

(Figure 1 Source: http://www.scholarpedia.org/article/Visual_salience#Beyond_biology:_technological_applications)

A lack of visual stimuli can slow down the process of forming a geological picture, as areas of interest are located through prolonged scans and later forgotten while performing other prolonged scans. Researchers believe we hold about 5-7 items in short term memory. [5] This can cause a problem for interpreters as visual assumptions are based on incomplete data using visual clues, and generally compare the visual information on seismic data with a frame of reference based on geological analogues retained in their memory.[6] The lack of visual clues subsequently hinder their associative memories being recalled; as non-conscious links between co-occurring stimuli (visual clues) are required for memory recall. [7]

Within the context of seismic interpretation, processing the data to increase visual salience of anomalies (or geological features of interest) is thought to enable the interpreter to more easily detect desired regions without the need for prolonged scans. To this end many seismic attributes that condition amplitude seismic data to emphasise specific aspects of the geology already exist.

This paper reviews some of the questions that we need to examine if a deeper understanding of visual salience and other aspects of visual perception is to help us define techniques for presenting seismic data in a way that can improve the effectiveness and efficiency of seismic interpretation. Questions include:

- Can visual clues that attract attention also hinder comprehensive interpretations?

- Should a perfect attribute highlight only geological features of interest and exclude all other stratigraphic information, or is the surrounding context necessary?
- What effect does colour maps selection have on visual attraction?
- Are visual clues derived from seismic processes and workflows influential in altering one's interpretation?

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