Enabling Spherical Vision

Karen Bemis[1], Alfie Abdul-Rahman[2], Min Chen[2], Saiful Khan[2], Eamonn Maguire[2], and Simon Walton[2]
[1]Rutgers University and [2]Oxford University

In deep-sea exploration, scientists (e.g., marine geologists and marine biologists) cannot see much except walls of dark water as ordinary light only penetrates 10-20 m into the darkness due to the high absorption rates of water. Instead, they have to rely on various sensors, such as ultrasonic scanning, to make sense of the surrounding. They would love to be able to visualize the complex environment of rifts, cliffs, lava pillars, black smoker chimneys and biota surrounding their underwater vehicle. Due to the very confined space in such a vehicle, it is not possible to have a sufficient number of display devices to convey the spherical and volumetric environment, that is, its left and right, front and back, above and below, and close and distant. We thus propose the following grand challenge:

To develop a technology that enables users to visualize a spherical and volumetric environment without using traditional display devices as a medium.

This technology will of course be realized step-by-step, for example, (i) first enabling direct simulation of any part of the pathway between optical nerves and visual cortex, bypassing the eye; (ii) next facilitating perceptual formulation or cognitive reconstruction of a single flat image; (iii) then a spherical vision; and (iii) finally a volumetric vision.

Such a technology can bring some significant benefits to many applications, including but not limited to:

- True spherical vision (all way around) for patients who cannot move their head easily, e.g., those suffering from motor neuron disease.
- A visual aid for vision impaired persons.
- Effective environmental awareness in underwater applications.
- A true volumetric view in medical imaging visualization.
- Exploration of virtual environments, such as a subsurface oil reservoir.
- Overcome the physical and functional limitations of display devices.

Such a technology will be revolutionary, since none of any existing technologies, such as panoramic screens, stereoscopic displays, volumetric displays or smart glasses, can achieve such effects.

One may wonder if such a technology is feasible or not. In fact, a recent advancement in the sciences has confirmed that it is feasible to realize the key requirement, that is, the ability to stimulate vision directly without following every step in the conventional pathway of perceive visual signals. We now understand how neurons are stimulated much better than before, and will continue to improve our understanding in the future. With such understanding, we can map visual signals from a specific visualization to appropriate stimulation signals, which can be delivered directly to the brain. The book “Computational Maps in the Visual Cortex” (by Miikkulainen, Bednar, Choe, and Sirosh) has already documented a wealth of knowledge for working towards such a technology. Meanwhile, many experiments, such as those led by Miesenböck at Oxford, show that brain circuits can be reprogrammed. For example, in optogenetics, light is used to observe and control groups of neurons (for details, please read Miesenböck, “Lighting up the Brain”, Scientific American, 2008).