

Humanoid Eyes: Perspective & Challenges

Ahmad Yousef¹

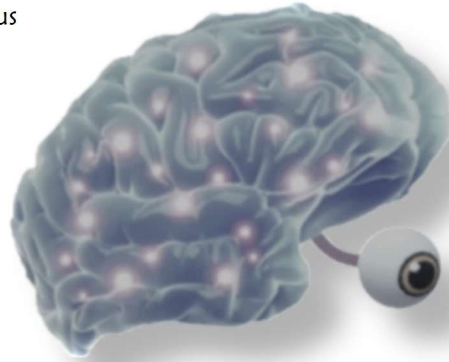
School of Computational Science and Engineering¹

McMaster University, Hamilton, Ontario, Canada

We initially have to understand the behaviors of human eye to comprehend its social importance. four dynamics (dimensions) distinguish human eyes: pupil variations, saccadic eye movements, blinks, in addition to duchenne markers (that is mainly produced by orbicularis oculi pars lateralis). Each of these dimensions represents significant amount of psychological and cognitive [1 - 7], and their corresponding neurophysiological information [8 - 11]. Hypothetically, proper analysis of these four spatiotemporal dynamics along with their corresponding neural activities (as responses to various perceptual and multisensory stimuli along with their corresponding decisions and possible actions) might eventually allow us to partially read the neural activities of the brain. Detailly speaking, this might be done after matching the continuum that includes the four previously mentioned dynamics with its corresponding cortical and subcortical neural activities from the data triggered by different external stimuli, and gathered simultaneously through various brain imaging techniques, and eye trackers. We offer these speculations to allow the readers to comprehend the importance of the eye's dynamics. Ultimately, we hope to gather additional evidences to confidentially say; the eye may be considered as a visible brain. Until several fine-tuned psychophysical experiments are achieved, our speculations may still have sensible credibility, by reviewing the current available literature. Eventually, we hope to say it confidentially, the eye might be exhibited as the most valuable visible organ for socialization.

Humanoids are mainly made for socialization purposes; and to humanize them, their eyes (visible brains) should be perfectly designed. Robotics Engineers should therefore understand the importance of the eyes. Namely, they should take the four previously mentioned dynamics into their design considerations. Humanoids might be very important in assisting vulnerable and elderly people in their daily tasks. Needless to say, without humanized eyes, the social

relationship between the owners and their humanoids may be impaired. Psychiatrists also might not rely on humanoids with imperfect humanized eyes to treat their patients. For example, children with autism spectrum disorder had been suffering from eye contact avoidance. Those patients, however, might accept to deal with a humanoid and might look at its eye quiet often, but not at a human eye. Humanoid eyes should be therefore perfectly humanized, to promote the recovery of the symptom through near-natural eye contacts.



Engineers therefore should collaborate with their colleagues' psychologists and neuroscientists more intensively to figure out the precise continuum of the dynamic of the human eye. Clearly, the biggest challenge for humanoid eyes is to understand the human eye precisely. Once the continuum is precisely calibrated, mathematical model can be developed, and engineers can afterwards implement that algorithm within humanoids.

Out of this project scope, however, neuroscientists, after having the previous continuum computational model, might be able to read the human brain with cheaper tools, namely, by eye trackers or professional cameras.

References

- [1] Kowler, E., Anderson, E., Doshier, B., & Blaser, E. (1995). The role of attention in the programming of saccades. *Vision Research*, 1897–1916.
- [2] Paprocki and Lenskiy (2017). What Does Eye-Blink Rate Variability Dynamics Tell Us About Cognitive Performance?. *Front. Hum. Neurosci.*
- [3] Darwin, C. (1872). The expression of emotion in animals and man.
- [4] Otero-Millan (2008). Saccades and microsaccades during visual fixation, exploration, and search: Foundations for a common saccadic generator. *Journal of Vision*.
- [5] Bradley, (2008). The pupil as a measure of emotional arousal and autonomic activation. *Psychophysiology*, 45(4), 602–607.
- [6] A. Urai, A. Braun & T. Donner (2017). Pupil-linked arousal is driven by decision uncertainty and alters serial choice bias. *Nature Communications*.
- [7] Einhäuser, CKoch and O. Carter (2010). Pupil dilation betrays the timing of decisions. *Frontiers in Human Neuroscience*.
- [8] Ivan Smalianchuk, Jagadisan and Gandhi. (2018). Instantaneous Midbrain Control of Saccade Velocity. *Journal of Neuroscience*.
- [9] Rylan S. Larsen and Jack Waters (2018). Neuromodulatory Correlates of Pupil Dilation. *Front. Neural Circuits*, 2018.
- [10] B J. L. Anderson S. I. Head C. Rae J. W. Morley (2002). Brain function in Duchenne muscular dystrophy. *Brain*, 2002.
- [11] Siri Leknes, *etal.* (2012). Oxytocin enhances pupil dilation and sensitivity to 'hidden' emotional expressions. *Social Cognitive and Aff. Neuroscience*.