BIODeeprid: BIO-inspired Deep neural network and hybrid system design under degraded imaging conditions

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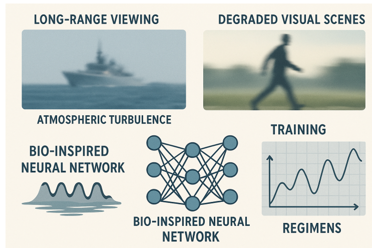
Project No: 50192



Fully funded M.S. and Ph.D. positions are available!

Project Description:

Artificial Intelligence has made a profound impact on various facets of human interaction, including rule-based tasks, computer vision, gaming, interactive education, and healthcare, revolutionizing the way we engage with technology and each other. While our comprehension of prominent computational frameworks like deep neural networks (DNNs) has grown since their inception, we still remarkably lack a comprehensive understanding of the underlying mechanisms responsible for their impressive performance. An approach to comprehend and interpret these networks involves leveraging human behavioral and physiological data. This approach can aid in the development of fully automized machines that exhibit out-of-distribution generalizability, with a specific focus on the underlying mechanisms of human vision. However, a notable drawback of fully automated architectures is their diminished performance when faced with varying degraded viewing conditions, long-range perspectives, fluctuations in lighting, line drawings, and atmospheric turbulence. Traditional solutions like data augmentation and summarization would offer no assistance because of the complex and unpredictable nature of real-world degradations. Considering the human involvement, it is crucial to assess how these conditions impact the performance of facial and body recognition systems, especially within the broader context of national security and public safety. On the other hand, human performance tends to thrive in such challenging or unnatural circumstances. Therefore, gaining insights into human performance through the analysis of behavioral and physiological cues could prove extremely valuable. A notable aspect of our proposal is the integration of machine and human performance, which serves two significant purposes: (1) maintaining human involvement to alter traditional inductive biases and (2) harnessing their complementary attributes to enhance overall generalization performance. Furthermore, the existing body of literature appears to be missing a structured framework, in short of proposing appropriate metrics, for comparing humans to DNNs across essential ecological viewing parameters. This deficiency leads to inconsistent and highly unreliable comparisons. Unlike prior computational vision research, our project places significant reliance on human experiments and openly accessible datasets. We utilize these resources to apply authentic analysis methods in the development of innovative DNN architectures. These architectures encompass various aspects, such as robustness to blurriness, adaptable kernel sizes, neural collapse, enforcement of invariance, extraction of identity representations, the application of information theory-based metrics for comparisons, and the integration of human-inspired explainability features. Collectively, our objective is to create DNN systems that are both adaptable and resilient, capable of performing reliably in highly adverse environmental conditions. In pursuit of this goal, we also seek to address fundamental scientific questions. For instance, we aim to leverage insights gained from our human-inspired designs to shed light on the mechanisms underlying information processing in the human brain, a subject that has intrigued researchers for decades and holds the potential to unlock a deeper understanding of cognitive processes and DNNs. The project's broad impact will be enriched by disseminating the results through well-known conferences, seminars, special sessions, and courses.

Dr. Şuayb Arslan (a faculty member in the Department of Computer Engineering at Boğaziçi University and a researcher at MIT in the USA) is the principal investigator of the project, which will continue for 36 months. In addition, researcher Tuna Çakar (a faculty member in the Department of Computer Engineering at MEF University) will provide support as an expert academician in the fields of cognitive sciences and electrophysiology. The project also plans to include a full-time PhD and a full-time master's student.

Keywords: Deep Learning, Human Vision, Computational Neuroscience, Turbulance, Human-Machine Hybrid Systems.

Project Management:

1. Prof. Suayb S. Arslan (PI), Dept. of Comp. Engineering at Bogazici University and Research Affiliate, Brain and Cog. Sciences at MIT.
2. Assoc. Prof. Tuna Çakar (Co-PI), Dept. of Comp. Engineering, MEF University.

Applications and Compensations: Funding is available for M.S. and Ph.D. degrees.

1. Master of Science (M.S), 19000TL + benefits
2. Philosophy of Doctorate (Ph.D), 27500TL + benefits

Please see for more info at TUBITAK's web page: `https://tubitak.gov.tr/en/funds/academic/national-support-programs/1001-scientific-and-technological-research-projects-funding-program`.

Bonus: Opportunity to collaborate with a research group at MIT, with the possibility of a summer visit to the lab, contingent on the availability of external funding (e.g., TUBITAK, MIT MISTI, etc.). Guidance and help will be provided.

All applicants are encouraged to contact the PI and Co-PIs of the project should there be any interest to engage and contribute to this new exciting field. All questions about the logistics and official applications (A resume with previous project experience and publication record) should be directed to ***suayb.arslan@bogazici.edu.tr***. The available positions will be filled on a first-come, first-serve basis upon successful fulfilment of project requirements.