ME – PhD Thesis Colloquium

An Active Ideation Framework using Creative Machines for Synergistic Human-AI Collaboration

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ABSTRACT

Ideation has driven human progress from the discovery of fire to Archimedes principle to Newton's theory to Einstein's relativity. Yet creativity remains limited by individual knowledge and the mind's unpredictable ability to connect ideas. In product design, particularly for novice designers, this poses problems such as design fixation, mental fatigue, and cognitive blocks. This thesis presents GEMINI (Generation, Evaluation, Management, INspiration for Ideation), a framework that shifts design from Computer-Assisted Design (CAD), where machines follow orders, to Designer-Assisting Computers (DAC), where AI works as an active partner alongside designers. GEMINI addresses four stages of design. For Generation, GENIE structures problems and ideas using a fine-tuned language model, while MIDAS uses thirteen AI agents to ensure every new idea is genuinely novel (locally and globally). For Evaluation, MAGICS converts ideas into mathematical representations and measures diversity through Idea Sparsity and Cluster Sparsity metrics, helping designers find unique solutions without feeling overwhelmed. For Management, DIMES introduces sGIT, a novel version control system for sketching that captures not just what designers draw but why they draw it through multi-modal annotations. The AEGIS system achieved 98.95% accuracy in classifying stroke types, enabling 800% more process detail to be captured. For Inspiration, EUPHORIA creates virtual reality spaces where eye-tracking captures what designers see which in turn was shown to correlate with what they prefer, and RETINA transforms these preferences into realistic product images. FENSO enables step-by-step collaborative complex form generation between designer and AI. Testing on real design projects showed the DAC workflow was over four times faster than traditional methods, reducing design time from four hours to under fifty minutes. Expert evaluations confirmed higher quality outputs. For many years, creativity has been something mysterious that stayed inside people's minds. This research probes in a direction that attempts to open this black box of creativity through machines so as not to replace human nor human thinking, but to make a truly synergistic human-AI collaboration. (Details about the work is available in: https://sankar-phd.in/)

ABOUT THE SPEAKER

Sankar Balasubramanian received his B.E. and M.E. in Mechanical Engineering from Government College of Engineering, Tirunelveli, where he was University First Rank Holder and Best Outgoing Student. He is currently completing his Ph.D. in Computational Product Design & XR at the Indian Institute of Science (IISc), Bangalore, under Prof. Dibakar Sen. His research focuses on GEMINI, an active ideation framework for synergistic human-AI collaboration, spanning AI, Extended Reality (XR), and Human-Computer Interaction. Prior to his doctoral studies, he served as Assistant Professor at Thiagarajar College of Engineering, Madurai. His work has been published in journals including AIEDAM (Cambridge University Press), Journal of Engineering Design (Taylor & Francis), and ACM ETRA, DS iCoRD, PLMSS earning multiple Best Paper Awards.

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