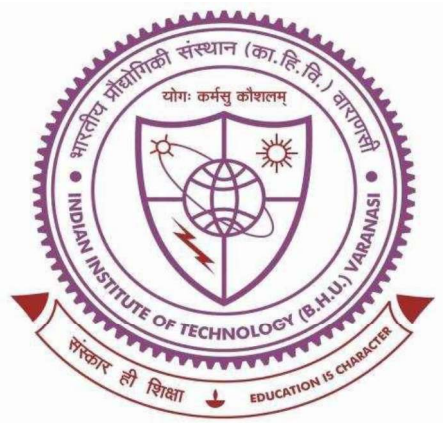
PREDICTION OF HUMAN PERFORMANCE USING EEG DATA TO IMPROVE SAFETY AND PRODUCTIVITY



Thesis submitted in partial fulfilment for the Award of Degree

Doctor of Philosophy

By

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CERTIFICATE

It is certified that the work contained in the thesis titled "PREDICTION OF HUMAN PERFORMANCE USING EEG DATA TO IMPROVE SAFETY AND PRODUCTIVITY" by "GUNDA YUGA RAJU" has been carried out under our supervision and that this work has not been submitted elsewhere for a degree.

It is further certified that the student has fulfilled all the requirements of Comprehensive Examination, Candidacy and SOTA for the award of Ph.D. Degree.

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DECLARATION BY THE CANDIDATE

I, GUNDA YUGA RAJU, certify that the work embodied in this thesis is my own bona fide work and carried out by me under the supervision of PROF. SUPRAKASH GUPTA and DR. LALIT KUMAR SINGH from JULY 2017 to JUNE 2023, at the DEPARTMENT OF MINING ENGINEERING, Indian Institute of Technology (BHU), Varanasi. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not wilfully copied any other's work, paragraphs, text, data, results, etc., reported in journals, books, magazines, reports dissertations, theses, etc., or available at websites and have not included them in this thesis and have not cited as my own work.

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It is certified that the above statement made by the student is correct to the best of our knowledge.

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Acknowledgement

I am filled with deep gratitude as I reflect upon completing this dissertation. I would like to express my sincere appreciation to all who have supported me throughout this journey.

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journey has been truly inspiring. Her love and encouragement have given me the strength to persevere, and I am forever grateful.

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Preface

This thesis presents the culmination of an extensive research endeavour to explore the subject of cognitive assessment and its practical implications. In this preface, the research work is briefly introduced, highlighting its subject, scope, aims and the philosophy that guided the approach of this study.

The subject of this research revolves around comprehending and evaluating cognitive processes concerning task performance. This study probed the intricate workings of the human mind, specifically focusing on general cognitive abilities such as attention and working memory. It aims at developing an objective assessment tool that can precisely predict cognitive performance in upcoming tasks.

The scope of this research is comprehensive, encompassing various aspects of cognitive assessment and performance optimisation. The study explored the interplay between cognitive processes and task demands to uncover the underlying mechanisms that determine successful performance. The investigation spanned multiple disciplines, including psychology, neuroscience and human factors engineering, as it strived to develop a holistic understanding of cognitive capabilities and their relevance in real-world contexts.

The primary aim of this research is to contribute to the development of standardised and reliable assessment tools for evaluating cognitive processes. The study recognised the need for objective measures to capture an individual's cognitive abilities, enabling organisations to make informed decisions regarding training interventions, resource

allocation and safety enhancement. This study aims to bridge the gap between theoretical knowledge and practical implementation, providing actionable insights that can improve human performance and safety outcomes.

The philosophy of the approach of this research is rooted in the information-processing perspective of human performance. Since cognition relies on individual attention resources and working memory capacity, a methodology was adopted that involves collecting and analysing physiological measures, specifically EEG data from the prefrontal cortex. These measures unintentionally reveal an individual's attentional and working memory status, providing valuable insights into his/her cognitive capabilities. This approach emphasises integrating advanced analysis techniques and innovative assessment methodologies to create a model that can predict cognitive performance with reasonable accuracy.

This dissertation is expected to embark on a journey that explores the intricacies of cognitive processes, the development of assessment tools and their practical applications. Upholding the highest ethical standards and promoting responsible data use with the ensured. With a deep appreciation for the complexity of human cognition, the study aims to contribute to the academic understanding of cognitive assessment while offering practical insights that can improve performance and safety in various domains.

The readers are invited to go through the findings, methodologies and implications of this research. This dissertation is expected to serve as a valuable resource for researchers, practitioners and individuals interested in the fascinating world of cognitive assessment and its impact on human performance.

Thank you for embarking on this journey with the researcher.

Publications

Publications as first author:

- Gunda, Y.R., Gupta, S. & Singh, L.K. Assessing human performance and human reliability: a review. Int. J. of System Assurance Engineering and Management 14, 817–828 (2023). https://doi.org/10.1007/s13198-023-01893-5
- Gunda, Y.R., Gupta, S. & Singh, L.K. Prediction of human performance using EEG data to improve safety and productivity in the mines. Int. J. of Reliability and Safety (Accepted)

Related publications as co-author:

- Arra, K., Gunda, Y.R. & Gupta, S. Development of a predictive model for workers' involvement in workplace accidents in an underground coal mine. Sādhanā 48, 63 (2023). https://doi.org/10.1007/s12046-023-02121-3
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- Gupta, S., Kumar, P., & Gunda, Y.R. (2021). A fuzzy causal relational mapping and rough set-based model for context-specific human error rate estimation. International Journal of Occupational Safety and Ergonomics, 27(1), 63–78. https://doi.org/10.1080/10803548.2019.1578114

Personal Profile

Gunda Yuga Raju is an aspiring educator with a passion for teaching and a strong academic background in Mining Engineering. He completed his Bachelor of Technology in Mining Engineering from the University College of Engineering, Kakatiya University, Telangana, where he achieved an impressive distinction with a 76% overall grade.

Driven by his love for knowledge and pursuit of excellence, Yuga Raju pursued further education. He earned his Master of Technology degree from the prestigious Indian Institute of Technology (IIT BHU) in Varanasi. During his postgraduate studies, he excelled academically, achieving a commendable Cumulative Performance Index (CPI) of 7.9.

Yuga Raju is continuing his academic journey as he pursues a Ph.D. from IIT BHU. He is deeply engrossed in his research on human reliability, exploring ways to improve and enhance human performance in various fields. Through his doctoral work, he aims to contribute to advancing knowledge and making a meaningful impact on society.

Alongside his research pursuits, Yuga Raju nurtures a profound passion for teaching. He firmly believes in the transformative power of education and aspires to become a teacher, shaping young minds and empowering the next generation. With his strong academic foundation, research expertise, and genuine enthusiasm for imparting knowledge, Yuga Raju aims to inspire and educate students, fostering a love for learning and guiding them towards their academic and personal growth.