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# Applying Generative Artificial Intelligence Tools in Remote Online Labs for Logic Expressions Minimization

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## ABSTRACT

This paper presents an enhanced remote online lab prototype that enables learners to design and experiment with digital circuits realizing minimized logic expressions. Building on our previous work with AND and OR logic gates, this paper introduces using Generative Artificial Intelligence (GAI) powered tools to facilitate the minimization process. Learners are provided with a logic expression to minimize before constructing the corresponding circuit. To validate their work, GAI-driven checks are implemented using state-of-the-art large language models (LLMs) including OpenAI ChatGPT3.5/4.0, Meta AI, and Meta Llama 3.1-405B. These LLMs were trained to minimize logic expressions through iterative refinement, comparing the number of steps required for each method across multiple iterations. Ten learners participated in constructing the minimized logic expression virtually and tested its operation in an on-campus lab using a webcam. Survey results showed that the application is user-friendly, allowing participants to construct and test the logic expressions easily within a reasonable amount of time. Furthermore, among all LLMs used in our project, the Meta AI tool demonstrated reliability and effectiveness in supporting the minimization of 4 variables logic expressions, with 100% of participants achieving the correct expression minimization result.

**Keywords**: GAI, generative artificial intelligence, LLM, large language model, Online education, Engineering program, Experiential learning, Virtual laboratory, Virtual systems construction, Simulation, Customizable simulations