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Integrating LSTM, CNN, and Reinforcement Learning for Adaptive Human–Computer Interaction in Windows Applications

والشبكات العصبية الالتفافية (LSTM) دمج الشبكات العصبية طويلة الذاكرة
والتعلم التعزيزي لتفاعل الإنسان والحاسوب التكيفي في تطبيقات (CNN)
نظام ويندوز

1. Introduction

In recent years, the interplay between artificial intelligence (AI) and human computer interaction (HCI) has gained considerable traction as researchers strive to move beyond static interface paradigms toward adaptive, predictive and context aware systems. For instance, Brdnik et al. (2022) provide a comprehensive mapping of how intelligent user interfaces (IUIs) leverage AI in HCI to enhance usability and user experience. Meanwhile, Saudi Arabia is actively positioning itself as a major player in the AI domain, with the Saudi Data & Artificial Intelligence Authority (SDAIA) reporting that the Kingdom is aligning AI adoption with its Vision 2030 goals across investment, infrastructure, talent development and service delivery (SDAIA, 2024). Despite this momentum, many Windowsbased desktop applications (e.g., particularly in the Saudi context) continue to rely on static menu structures, fixed layouts and nonadaptive interaction patterns, leaving significant room for improvement in usability, accessibility and user satisfaction. This proposal explores how AI techniques can be embedded into Windows HCI applications to deliver more adaptive, culturally and contextually relevant interfaces in Saudi Arabia.

1.1 Problem Statement

The core problem statement is that existing Windows desktop applications in Saudi Arabia largely lack adaptive, AI-driven interaction capabilities. These limitations manifest in longer task completion times, interface inflexibility, and reduced user satisfaction, especially given the diversity of user profiles (language, culture, accessibility). Current research in AIHCI has focused more heavily on web and mobile platforms and tends to apply singular AI techniques (e.g., machine learning for recommendations) rather than integrated frameworks combining sequence modelling, GUI element recognition and reinforcement learning for desktop GUIs.

1.2 Therefore, the research question is: How can AI be designed and applied to Windows HCI applications in Saudi Arabia to produce adaptive, usercentered interfaces that improve usability, accessibility, and user satisfaction compared with traditional nonadaptive approaches?

1.3 Research Objectives

Accordingly, the research aims to develop and evaluate a novel AI-based adaptive HCI model tailored for Windows desktop environments and contextualized for Saudi Arabia. The objectives supporting this aim include:

- o To design an AIHCI framework that integrates LSTM (for interaction sequence prediction), CNN (for GUI element recognition) and reinforcement learning (for adaptive UI changes);
- o To implement the model using publicly available GUI interaction datasets simulating Windows desktop usage;

- o To empirically evaluate the model's performance and comparing it with a traditional baseline interface in terms of prediction accuracy, task completion time and user satisfaction; and
- o To analyze the implications of deploying such adaptive AI interfaces within Saudi Arabia, including language, culture and accessibility considerations.

1.4 Research Scope

The scope of the research is defined as follows: the focus is exclusively on Windows desktop applications rather than mobile or web platforms. The study emphasizes AI-driven adaptive interface design (rather than backend or purely aesthetic changes). Evaluation will be conducted on public datasets and simulated user scenarios (rather than a full live deployment in Saudi organizations at this stage). While the model will be contextualized for Saudi Arabia (e.g., Arabic language, cultural norms), the primary evaluation data may not originate from Saudi users.

1.5 Research Significance

The significance of this research lies in filling multiple gaps: it addresses a platform specific under explored area (Windows desktop HCI), applies AI-based techniques within HCI rather than a single method, provides empirical evaluation using usability as well as predictive metrics, and offers relevance to Saudi Arabia's digital transformation agenda by suggesting adaptive interfaces suited for local language, culture and accessibility needs.