

Ministry of Education and Science of Ukraine

**KHARKIV NATIONAL UNIVERSITY OF RADIO ELECTRONICS
RIGA NORDIC UNIVERSITY
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Eighth International
Scientific and Technical Conference



«COMPUTER AND INFORMATION SYSTEMS AND TECHNOLOGIES»

October 09-10

Kharkiv 2025

Eighth International Scientific and Technical Conference «COMPUTER AND INFORMATION SYSTEMS AND TECHNOLOGIES». Kharkiv: NURE. 2025. – 125 p.

This publication is prepared by
Department of Electronic Computers
KHARKIV NATIONAL UNIVERSITY OF RADIO ELECTRONICS (NURE)



NURE

Харківський національний університет
радіоелектроніки

61166, Ukraine,
14 Nauky Avenue, Kharkiv
tel: +38 (057) 702-13-54
E-mail: info@csitic.com
Online ISSN: 2710-463X

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of Radio Electronics (NURE), 2025

Correlation Analysis in User Interface Architecture Optimization

Ni Oleh Vyacheslavovych

Shostak Maksym Vitaliyovych

Piskarev Oleksiy Mykolaiovych

Ni Yana Samvelivna

Kharkiv National University of Radio Electronics, 14 Nauky Ave,
Kharkiv UA-61166, Ukraine, oleh.ni@nure.ua

Kharkiv National University of Radio Electronics, 14 Nauky Ave,
Kharkiv UA-61166, Ukraine, maksym.shostak@nure.ua

Kharkiv National University of Radio Electronics, 14 Nauky Ave,
Kharkiv UA-61166, Ukraine, oleksii.piskarov@nure.ua

Kharkiv National University of Radio Electronics, 14 Nauky Ave,
Kharkiv UA-61166, Ukraine, yana.movsesian@nure.ua

Abstract. This paper presents a systematic methodology for applying correlation analysis to optimize graphical user interface architecture in software systems. Simulation modeling based on secondary data from the hcidata database with parameters of 30 virtual operators confirmed statistically significant correlations (0.26-0.85) between interface parameters and performance indicators. An integrated mathematical model (IPE) was developed with 79.2% accuracy. The modeling showed that increasing button size from 32×32 to 48×48 pixels reduced errors by 42%, while increasing contrast from 3:1 to 4.5:1 reduced cognitive load by 18%. Economic analysis demonstrated ROI of 300% with a 3-month payback period.

Keywords: software architecture; graphical user interface; correlation analysis; system performance; UI optimization; human-computer interaction.

I. INTRODUCTION AND PROBLEM STATEMENT

Modern software systems increasingly focus on high-quality human-computer interaction, where GUI architecture plays a key role. Non-optimal architectural decisions can reduce software performance by 15-40%, particularly critical for real-time and high-load computing environments [1]. Early approaches based on Nielsen's heuristic principles showed that experts can identify only about half of real interface problems [2]. Mathematical models including Fitts's law and the GOMS model [3] remain simplified and do not account for multidimensional context.

A significant challenge is the replication crisis: less than a quarter of HCI experiments can be reproduced [4] due to small samples and lack of standardized methodologies. Recent studies show that non-optimal decisions increase response time by 200-300% [5], while optimization can reduce resource consumption by 35-45%. Despite the implementation of machine learning in interface analysis, meta-analyses show low correlations between metrics, though specialized experiments demonstrate higher values [6].

The research hypothesis posits that GUI architectural parameters have stable correlational relationships with objective system performance metrics, which can be formalized as a mathematical model for predicting UI efficiency.

II. PROBLEM SOLUTION AND RESULTS

Methodology. The methodological approach was based on the integration of system analysis principles, experimental psychology, and statistical modeling. Unlike traditional heuristic methods, the proposed methodology relies on

correlation analysis as a key tool for quantitative assessment [3].

The simulation was based on secondary data from the hcidata database [7] with parameters of 30 virtual operators (average age 34.2±8.1 years) distributed by experience: beginners (n=10), experienced (n=12), experts (n=8). Sample size was justified by power analysis [8] ($d=0.5$, $\alpha=0.05$, power=0.80). Variables varied: button size (32-56 px), contrast (2:1-7:1), font size (12-18 pt), element spacing (4-16 px).

Interface efficiency was evaluated based on three scenarios: precise positioning, parameter input, and status diagnostics. Both objective metrics (task time, error count, IPE) and subjective measures (NASA-TLX, SUS) were applied. Pearson correlation coefficients were calculated with Bonferroni correction [8] ($\alpha=0.001$).

Results. The analysis of 270 virtual scenarios provided over 1.84 million data points. Average task completion time was 28.3 seconds (range 14.2-67.8), with error count 0-8 (average 2.4).

Strong correlations were established between interface parameters and performance. Button size showed the strongest impact ($r=-0.85$ with errors, $r=-0.78$ with time, $p<0.001$), with an increase from 32×32 to 48×48 pixels reducing errors by 42% and time by 18.6 seconds. Contrast showed moderate correlations ($r=-0.52$ with time, $p<0.01$), with improvement from 3:1 to 4.5:1 reducing time by 28% and cognitive load by 18%. Multiple regression showed $R^2=0.83$ for errors and $R^2=0.74$ for task time ($p<0.001$).

An integrated IPE model was developed: $IPE = 0.52(X/56) + 0.21(C/7) + 0.17(F/18) + 0.10(12/D)$, achieving 79.2% accuracy with $R^2=0.743$. Differentiated recommendations were formulated: office systems (buttons 48-52 px, contrast $\geq 4.5:1$, $IPE \approx 0.83$), industrial HMI (buttons 48-56 px, contrast $\geq 6:1$, $IPE \approx 0.90$), critical systems (buttons 56 px, contrast $\geq 7:1$, $IPE=1.0$).

Economic analysis for a 25-operator enterprise showed 18% time reduction, annual savings of 100,000 UAH with 25,000 UAH implementation costs (ROI 300%, 3-month payback).

III. CONCLUSIONS

The methodology of applying correlation analysis for quantitative establishment of dependencies between GUI parameters and system performance was proposed and validated through simulation. The strongest impact was demonstrated by element size ($r=-0.85$, $p<0.001$) and font size ($r=-0.61$, $p<0.01$). An integrated IPE model provided 79.2% accuracy ($R^2=0.743$) for automated UI optimization.

Results showed differentiation by expertise level: beginners rely on button size, experienced users balance multiple factors, experts prioritize visual characteristics. Economic analysis demonstrated annual savings of 100,000 UAH for medium enterprises with ROI of 300% and a 3-month payback period.

Simulation modeling created a reliable theoretical foundation for further empirical validation with real users. Future directions include real laboratory experiments with 30-50 operators, integration of AI methods for adaptive design, expansion to mobile and multimodal systems, and development of personalized optimization strategies.

REFERENCES

- [1] Zhang, J., & Johnson, K. A. (2022). Quantitative evaluation of GUI design patterns in enterprise applications. *ACM Transactions on Computer-Human Interaction*, 29(4), 1-28.
- [2] MacKenzie, I. S., & Read, J. (2024). Empirical research methods for human-computer interaction. *arXiv preprint arXiv:2404.13319*.
- [3] Card, S. K., Moran, T. P., & Newell, A. (1983). *The psychology of human-computer interaction*. Lawrence Erlbaum Associates.
- [4] Hornbæk, K., & Oulasvirta, A. (2017). What is interaction? In *Proc. of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 5040-5052). ACM.
- [5] Rodriguez, M., & Singh, P. (2021). Performance metrics for GUI optimization in industrial systems. *IEEE Transactions on Human-Machine Systems*, 51(6), 612-624.
- [6] Kim, H. J., & Lee, S. W. (2021). Empirical studies on GUI element sizing and user performance. *Behaviour & Information Technology*, 40(12), 1234-1249.
- [7] MacKenzie, I. S. (2024). hcidata: HCI Datasets. The Comprehensive R Archive Network (CRAN). <https://cran.r-project.org/package=hcidata>
- [8] • Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

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Scientific publication

«COMPUTER AND INFORMATION SYSTEMS AND TECHNOLOGIES»

Responsible for the release:

RUBAN Igor,
KOVALENKO Andriy,
MARTOVYTSKYI Vitalii

Computer layout:

KOVALENKO Andriy,
MARTOVYTSKYI Vitalii

Collection materials are published in the author's version without editing

Approved by the Scientific and Technical Council of Kharkiv National University of
Radio Electronics № 5/5 23.04.2021