

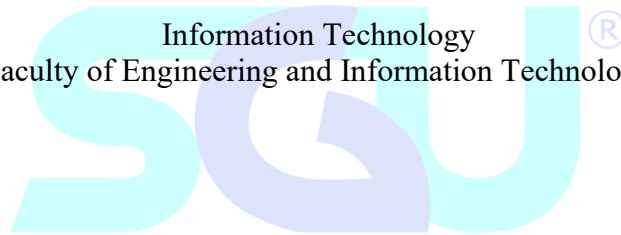
**Comparative Evaluation and Mobile Integration of Vision-Enabled LLMs for
Handwriting Recognition in Medical Prescriptions**

By

Nathanael Owen Kamto
12102010

BACHELOR'S DEGREE
in

Information Technology
Faculty of Engineering and Information Technology

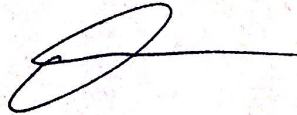


SWISS GERMAN UNIVERSITY
The Prominence Tower
Jalan Jalur Sutera Barat No. 15, Alam Sutera
Tangerang, Banten 15143 - Indonesia

Revision after the Thesis Defense on 9th July 2025

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.



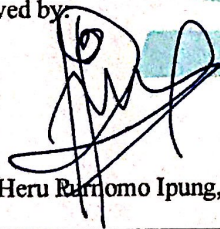
Nathanael Owen Kamto

Student

15/07/2025

Date

Approved by:



Dr. Ir. Heru Ruriono Ipung, M.Eng

Thesis Advisor

19/07/2025

Date

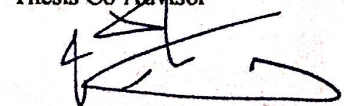


Assoc. Prof. Ir. James Purnama, M.Sc

Thesis Co-Advisor

15-7-2025

Date



Dr. Ir. Maulahikmah Galinium, S. Kom, M. Sc

Dean

19.7.2025.

Date

Nathanael Owen Kamto

ABSTRACT

Comparative Evaluation and Mobile Integration of Vision-Enabled LLMs for Handwriting Recognition in Medical Prescriptions

By

Nathanael Owen Kamto (*nathanael.kamto@student.sgu.ac.id*)

Dr. Ir. Heru Purnomo Ipung, M.Eng, Advisor (*heru.ipung@sgu.ac.id*)

Assoc. Prof. Ir. James Purnama, M.Sc, Co-Advisor (*james.purnama@sgu.ac.id*)

SWISS GERMAN UNIVERSITY

This study presents a comparative evaluation and mobile integration of modern vision-enabled Large Language Models (LLMs) for handwriting recognition in medical prescriptions. The research addresses the critical issue of illegible handwritten prescriptions in Indonesian healthcare by leveraging pretrained multimodal models that inherently combine visual and language processing capabilities. Unlike traditional approaches that require extensive manual preprocessing and feature extraction, the proposed system utilizes state-of-the-art LLMs to directly interpret handwritten text with minimal intervention. A series of experiments are conducted using a diverse dataset of handwritten prescription images, where various LLMs are benchmarked on evaluation metrics such as accuracy. The comparative analysis reveals significant variations in model performance, highlighting the robustness and efficiency of certain models in handling the complexities of diverse handwriting styles and localized medical terminology. Furthermore, the integration of the best-performing model into a mobile application demonstrates the practical viability of the approach, offering improved accessibility and streamlined workflow for both healthcare professionals and patients. These findings not only underscore the potential of vision-enabled LLMs in medical document processing but also pave the way for broader adoption in clinical settings.

Keywords: Vision-enabled LLM, handwriting recognition, medical prescriptions, comparative evaluation, mobile integration, Indonesian healthcare.



© Copyright 2025
by Nathanael Owen Kamto
All rights reserved

DEDICATION

I dedicate this work to the future of Indonesia, where every patient deserves clear, accurate prescriptions and improved healthcare outcomes. May this thesis contribute, in its small way, to advancing medical safety and accessibility for all.



ACKNOWLEDGEMENTS

I extend my deepest gratitude to my advisor, Dr. Ir. Heru Purnomo Ipung, M.Eng., whose expertise and thoughtful feedback guided this research from its inception to completion. I am equally grateful to my co-advisor, Assoc. Prof. Ir. James Purnama, M.Sc., for his valuable insights and encouragement in refining the methodology and analysis.

Thanks go to the faculty and staff of Swiss German University for providing the resources and a supportive environment essential to this work. I also wish to acknowledge my peers and the participants who generously took part in User Acceptance Testing, offering critical data and feedback.

Finally, heartfelt appreciation is owed to my family and friends for their unwavering confidence, understanding, and moral support throughout this journey. Their belief in my abilities sustained me through the challenges and inspired me to strive for excellence.

TABLE OF CONTENTS

STATEMENT BY THE AUTHOR	2
ABSTRACT	3
DEDICATION	5
ACKNOWLEDGEMENTS	6
TABLE OF CONTENTS	7
LIST OF FIGURES	9
LIST OF TABLES	10
CHAPTER 1 - INTRODUCTION	11
1.1 Background	11
1.2 Research Problems	12
1.3 Research Objective	12
1.4 Significance of Study	13
1.5 Research Questions	13
1.6 Hypothesis	14
1.7 Research Scope	14
CHAPTER 2 - LITERATURE REVIEW	16
2.1 Overview of Handwriting Recognition Systems.....	16
2.1.1 Classical OCR Baselines	16
2.1.2 Vision-Enabled LLM Baselines.....	17
2.2 Handwriting Recognition in Indonesian Healthcare	18
2.3 Related Works	19
2.3.1 Doctor's Cursive Handwriting Recognition System Using Deep Learning	19
2.3.2 Medical Prescription Recognition Using Machine Learning	20
2.3.3 Deep Learning Analysis in Development of Handwritten and Plain Text Classification API	20
2.3.4 Development of an on-Premise Indonesian Handwriting Recognition Backend System Using Open Source Deep Learning Solution for Mobile User	21
2.3.5 Handwriting Recognition in Historical Documents with Multimodal LLM	21
2.4 Related Works Comparison	23
2.5 Internal Architectures of Selected Vision-Enabled LLMs.....	24

2.6 User Acceptance Testing Practices in Pharmacy Settings	25
CHAPTER 3 - RESEARCH METHODS	27
3.1 Research Overview	27
3.1.1 System Architecture	27
3.1.2 System Architecture Details	29
3.2 Model Selection	30
3.3 Dataset Collection	31
3.4 Model Testing	32
3.5 Post-Processing	33
3.6 Mobile App Development and Integration	34
3.7 User Acceptance Testing (UAT)	34
CHAPTER 4 - RESULTS AND DISCUSSIONS	36
4.1 Benchmark Evaluation	36
4.1.1 Response Time	36
4.1.2 Text Similarity (Original vs. Corrected)	37
4.1.3 Statistical Summary	38
4.1.4 Accuracy-Speed Trade-off	40
4.1.5 Effect of Post-Processing	41
4.2 Mobile App Development and System Flow	42
4.3 User Acceptance Testing (UAT) Results	46
CHAPTER 5 - CONCLUSIONS AND RECOMMENDATIONS	51
5.1 Conclusions	51
5.2 Recommendations	51
5.3 Future Work	52
5.3.1 Regulatory & Clinical-Testing Considerations in Indonesia	52
5.3.2 Performance Monitoring & Model-Drift Detection	53
5.3.3 Future Extension: Dosage & Frequency Recognition	53
APPENDIX	54
REFERENCES	63
CURRICULUM VITAE	64

LIST OF FIGURES

Figures	Page
Figure 1. Research Flowchart.....	23
Figure 2. Architecture Diagram – System Components.....	23
Figure 3. Activity Diagram – System Flow.....	24
Figure 4. Sample handwritten prescription image.....	27
Figure 5. Sample handwritten prescription image.....	28
Figure 6. Screenshot of the Flutter mobile app interface.....	30
Figure 7. Boxplot of Response Time.....	32
Figure 8. Scatterplot of Response Time.....	33
Figure 9. Histogram of Similarity Score on Original Data.....	34
Figure 10. Histogram of Similarity Score in Corrected Data.....	34
Figure 11. Scatterplot of Response Time vs Original Similarity Score.....	36
Figure 12. Scatterplot of Response Time vs Corrected Similarity Score.....	37
Figure 13. Barchart of Models Accuracy.....	38
Figure 14. Camera Capture and Gallery Upload.....	38
Figure 15. App System Flow.....	39
Figure 16. Scraped Medication from Tokopedia.....	40
Figure 17. Display Medication Recognition Result.....	42

LIST OF TABLES

Table	Page
Table 1. Prior Handwriting Recognition Methods	17
Table 2. Benchmarked Vision-LLM Models.....	18
Table 3. Related Works Comparison Table.....	23
Table 4. Character-level Benchmark by Models	25
Table 5. System Architecture Components.....	29
Table 6. Summary Statistics by Model.....	39
Table 7. UAT Scenario Results Table.....	47
Table 8. UAT Scenario Results – Granular Breakdown.....	48