IMPLEMENTASI MODEL IndoBERT PADA CHATBOT KESEHATAN GIGI DENGAN ALGORITMA *MASKED LANGUAGE MODEL* DAN *NEXT SENTENCE PREDICTION*

SKRIPSI

Diajukan sebagai syarat untuk memperoleh gelar Sarjana Komputer
Program Studi Ilmu Komputer

Dosen Pembimbing:
Dr. Rasim, M.T
Ani Anisyah, M.T

Oleh:
Nadhief Athallah Isya
2106413

Program Studi Ilmu Komputer
Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam
Universitas Pendidikan Indonesia
2025

IMPLEMENTASI MODEL IndoBERT PADA CHATBOT KESEHATAN GIGI DENGAN ALGORITMA *MASKED LANGUAGE MODEL* DAN *NEXT SENTENCE PREDICTION*

Disusun oleh:
Nadhief Athallah Isya
NIM 2105413

Diajukan untuk memenuhi sebagian dari syarat untuk memperoleh gelar Sarjana
Program Studi Ilmu Komputer

© Nadhief Athallah Isya
Universitas Pendidikan Indonesia
17 Agustus 2025

Hak Cipta dilindungi Undang-Undang
Skripsi ini tidak boleh diperbanyak seluruhnya atau sebagian,
dengan dicetak ulang, difoto kopi, atau cara lainnya tanpa ijin dari penulis

LEMBAR PENGESAHAN

NADHIEF ATHALLAH ISYA
2106413

IMPLEMENTASI MODEL IndoBERT PADA CHATBOT KESEHATAN GIGI DENGAN ALGORITMA MASKED LANGUAGE MODEL DAN NEXT SENTENCE PREDICTION

DISETUJUI DAN DISAHKAN OLEH TIM PEMBIMBING:

Pembimbing I,

Dr. Rasim, S.T., M.T.
NIP. 197407252006041002

Pembimbing II,

Ani Anisyah, M.T.
NIP. 920200419930811201

Mengetahui,
Ketua Program Studi Ilmu Komputer

Dr, Muhammad Nursalman, S.Si,. M.T.
NIP. 197909292006041002

IMPLEMENTASI MODEL IndoBERT PADA CHATBOT KESEHATAN GIGI DENGAN ALGORITMA *MASKED LANGUAGE MODEL* DAN *NEXT SENTENCE PREDICTION*

Oleh
Nadhief Athallah Isya – nadhiefathallahi@upi.edu
2106413

ABSTRAKSI

Tingginya biaya konsultasi medis dan kurangnya distribusi tenaga medis yang merata di Indonesia menjadi hambatan signifikan bagi masyarakat dalam mengakses layanan kesehatan. Penelitian ini bertujuan untuk merancang dan mengembangkan chatbot kesehatan gigi menggunakan algoritma *Large Language Model* (LLM), khususnya BERT (*Bidirectional Encoder Representations from Transformers*). Dengan metodologi pengembangan perangkat lunak *Waterfall*, penelitian mencakup tahap analisis kebutuhan, desain, implementasi, dan pengujian sistem. Kebutuhan sistem diidentifikasi melalui studi literatur, observasi, dan konsultasi pakar, menghasilkan spesifikasi modul seperti registrasi pengguna, antarmuka percakapan, basis pengetahuan FAQ gigi, dan fitur rekam medis dalam bentuk PDF. Dataset dikembangkan dari korpus teks medis berbahasa Indonesia dan dilatih menggunakan pendekatan *Masked Language Model* (MLM) dan *Next Sentence Prediction* (NSP). Sistem chatbot dirancang dalam platform web yang mengintegrasikan model NLP berbasis IndoBERT dengan modul intent classification untuk mendukung percakapan lanjutan. Hasil pengujian menunjukkan respons cepat (rata-rata 541 ms), akurat, dan relevan, dengan hasil black-box testing yang valid serta throughput stabil. Validasi pakar menggunakan kuesioner skala Likert 1–5 menghasilkan skor rata-rata 3,61 dari empat aspek utama: relevansi, kejelasan, kesesuaian medis, dan kelengkapan informasi. Chatbot ini dinyatakan layak sebagai sarana konsultasi awal dan edukasi kesehatan gigi secara daring.

Kata Kunci: Asisten Kesehatan Virtual, Chatbot, Pengolahan Bahasa Alami, BERT

IMPLEMENTASI MODEL IndoBERT PADA CHATBOT KESEHATAN GIGI DENGAN ALGORITMA *MASKED LANGUAGE MODEL* DAN *NEXT SENTENCE PREDICTION*

Oleh
Nadhief Athallah Isya – nadhiefathallahi@upi.edu
2106413

ABSTRACT

The high cost of medical consultations and the unequal distribution of healthcare professionals in Indonesia pose significant barriers for the public in accessing healthcare services. This study aims to design and develop a dental health chatbot using a Large Language Model (LLM) algorithm, specifically BERT (Bidirectional Encoder Representations from Transformers). Employing the Waterfall software development methodology, the research encompasses requirement analysis, system design, implementation, and testing stages. System requirements were identified through literature review, observation, and expert consultation, resulting in specifications such as user registration, conversational interface, dental FAQ knowledge base, and medical record export in PDF format. The dataset was developed from Indonesian medical text corpora and trained using the Masked Language Model (MLM) and Next Sentence Prediction (NSP) approaches. The chatbot system was deployed on a web platform integrating the IndoBERT-based NLP model with an intent classification module to support extended conversations. Testing results demonstrate fast response times (average 541 ms), accurate and relevant answers, valid black-box testing outcomes, and stable throughput. Expert validation using a Likert-scale questionnaire (1–5) yielded an average score of 3.61 across four main aspects: relevance, clarity, medical appropriateness, and completeness of information. The chatbot is considered feasible as an initial consultation tool and an online dental health education medium.

Keywords: *Virtual Health Assistant, Chatbot, Natural Language Processing, BERT*

DAFTAR ISI

ABSTRAKSI iii
ABSTRACT iv
KATA PENGANTAR v
DAFTAR GAMBAR xi
DAFTAR TABEL xii
BAB 1 1
1.1 Latar Belakang 1
1.2 Rumusan Masalah 5
1.3 Batasan Masalah 6
1.4 Tujuan Penelitian 7
1.5 Manfaat Penelitian 7
BAB 2 9
2.1. Peta Literatur 9
2.2. Asisten Kesehatan Virtual 9
2.3. Chatbot 12
2.4. *Artificial Intelligence* 14
2.5. Machine Learning 15
2.6. *Natural Language Processing* 17
2.6.1. *Masked Language Model* (MLM) 18
2.6.2. *Next Sentence Prediction* (NSP) 19
2.6.3. *Intent Classification* 20
2.7. *Large Language Model* 21
2.8. BERT (*Bidirectional Encoder Representations from Transformers*) 22
2.8.1. *Self-Attention Mechanism* 23
2.8.2. *Knowledge Base* 24
2.8.3. Evaluasi Klasifikasi 24
2.8.4. IndoBERT 26
2.9. *Waterfall* 26

2.10. Penelitian Terdahulu 28
BAB 3 30
3.1. Desain Penelitian 30
3.1.1. Pengumpulan Data 30
3.1.2. Pengembangan Model IndoBERT 33
3.1.3. Penerapan Metode *Waterfall* 36
3.1.5. Kesimpulan 43
3.2. Alat dan Bahan Penelitian 43
3.2.1. Alat Penelitian 43
3.2.2. Bahan Penelitian 44
BAB 4 45
4.1. Identifikasi Masalah 45
4.2. Pengumpulan Data 46
4.2.1. *Knowledge Base* 46
4.2.2. *Next Sentence Prediction* (NSP) 48
4.2.3. *Intent Classification* 49
4.2.4. *Masked Language Model* 49
4.3. Pengembangan Model Chatbot 50
4.3.1. Pretrained dengan Masked Language Model (MLM) 50
3.4.2. Fine-Tuning dengan Next Sentence Prediction (NSP) 54
4.3.3. Fine-Tuning dengan Intent Classification 59
4.4. Analisis 67
4.4.1. Kebutuhan Fungsional 67
4.4.2. Kebutuhan non-Fungsional 69
4.5. Desain 70
4.5.1. Arsitektur 70
4.5.2. Flowchart Sistem Chatbot 73
4.5.3. Perancangan *User Interface* 75
4.5.4. Perancangan Database 78
4.6. Implementasi 79

4.6.1. Antarmuka Pengguna 80
4.6.2. Backend sistem 83
4.6.3. Model Chatbot dengan *Flask* API 85
4.6.4. Integrasi Antar Komponen Sistem 86
4.7. Pengujian 89
4.7.1. Fungsional *Testing* (*Black Box*) 89
4.7.2. Non Fungsional *Testing (Performance)* 92
4.7.3. Validasi Pakar 94
4.7. *Maintenance* 97
4.8. Kesimpulan 98
BAB 5 99
5.1. Kesimpulan 99
5.2. Saran 101
DAFTAR PUSTAKA 102

DAFTAR GAMBAR

Gambar 2.1 Peta Literatur 9
Gambar 2.2 Metode Waterfall (Sommervile, 2011) 27
Gambar 3.1 Desain Penelitian 30
Gambar 3.2 Skala Likert Joshi dkk (2015) 42
Gambar 4.1 Dataset Finetuning NSP 49
Gambar 4.2 Dataset Finetuning Intent Class 49
Gambar 4.3 Training Loss Finetuning MLM 54
Gambar 4.4 Training Loss Finetuning NSP 56
Gambar 4.5 Confussion Matrix Finetuning NSP 57
Gambar 4.6 Training Loss Finetunning Intent Class 62
Gambar 4.7 Confussion Matrix Finetuning Intent Class 63
Gambar 4.8 Arsitektur 70
Gambar 4.9 Flowchart Sistem Chatbot Kesehatan Gigi 74
Gambar 4.10 Rancangan Halaman Registrasi 76
Gambar 4.11 Rancangan Halaman Login 76
Gambar 4.12 Rancangan Halaman Percakapan Baru 77
Gambar 4.13 Halaman Percakapan Sudah Ada 77
Gambar 4.14 Desain Database Sistem Chatbot 78
Gambar 4.15 Halaman Registrasi 81
Gambar 4.16 Halaman Login 82
Gambar 4.17 Halaman Percakapan Baru 82
Gambar 4.18 Halaman Percakapan Sedang Berlangsung 83

DAFTAR TABEL

Tabel 4.1 Kerangka *knowledge base* 47
Tabel 4.2 Dataset MLM, NSP, dan *Intent Classification* 50
Tabel 4.3 Perbandingan sebelum dan sesudah Preprocess 51
Tabel 4.4 Classification Report NSP 58
Tabel 4.5 Classfication Report *Finetuning Intent Class* 64
Tabel 4.6 Kebutuhan Fungsional 68
Tabel 4.7 Kebutuhan Non Fungsional 69
Tabel 4.8 List Endpoint Sistem Chatbot 84
Tabel 4.9 Fungsional Testing 89
Tabel 4.10 Performance Testing 93

DAFTAR PUSTAKA

Adamopoulou, E., & Moussiades, L. (2020). An Overview of Chatbot Technology. In *IFIP Advances in Information and Communication Technology: Vol. 584 IFIP* (Issue June). Springer International Publishing. https://doi.org/10.1007/978-3-030-49186-4_31

Anandan, P., Kokila, S., Elango, S., Gopinath, P., & Sudarsan, P. (2022). Artificial Intelligence based Chat Bot for Patient Health Care. *2022 International Conference on Computer Communication and Informatics, ICCCI 2022*, *Iccci*, 1–4. https://doi.org/10.1109/ICCCI54379.2022.9740912

Anjum, K., Sameer, M., & Kumar, S. (2023). AI Enabled NLP based Text to Text Medical Chatbot. *Proceedings of 2023 3rd International Conference on Innovative Practices in Technology and Management, ICIPTM 2023*, *Iciptm*, 1–5. https://doi.org/10.1109/ICIPTM57143.2023.10117966

Balaji, S. (2012). Waterfall vs v-model vs agile : A comparative study on SDLC. *WATEERFALL Vs V-MODEL Vs AGILE : A COMPARATIVE STUDY ON SDLC*, *2*(1), 26–30.

Benington, D. (1983). *Production of Large Computer Programs*. *5*(4).

Bharti, U., Bajaj, D., Batra, H., Lalit, S., Lalit, S., & Gangwani, A. (2020). Medbot: Conversational artificial intelligence powered chatbot for delivering tele-health after covid-19. *Proceedings of the 5th International Conference on Communication and Electronics Systems, ICCES 2020*, *Icces*, 870–875. https://doi.org/10.1109/ICCES48766.2020.09137944

Bickmore, T., & Giorgino, T. (2006). Health dialog systems for patients and consumers. *Journal of Biomedical Informatics*, *39*(5), 556–571. https://doi.org/10.1016/j.jbi.2005.12.004

Bird, S., & Klein, E. (2011). Natural language processing with python. In *Indonesian Journal of Applied Linguistics* (Vol. 1, Issue 1). https://doi.org/10.17509/ijal.v1i1.106

Boehm, B. W. (2019). A Spiral Model of Software Development and Enhancement. *ACM SIGSOFT*, *11*(1), 1–14. http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

Brown, T. B., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., Agarwal, S., Herbert-Voss, A., Krueger, G., Henighan, T., Child, R., Ramesh, A., Ziegler, D. M., Wu, J., Winter, C., … Amodei, D. (2020). Language models are few-shot learners. *Advances in Neural Information Processing Systems*, *2020-Decem*.

Budiaji, W. (2013). The Measurement Scale and The Number of Responses in Likert Scale. *Jurnal Ilmu Pertanian Dan Perikanan Desember*, *2*(2), 125–131. http://umbidharma.org/jipp

Chowdhury, G. G. (2003). Natural language processing. *Annual Review of Information Science and Technology*, *37*, 51–89. https://doi.org/10.1002/aris.1440370103

Dale, R. (2016). The return of the chatbots. *Natural Language Engineering*, *22*(5), 811–817. https://doi.org/10.1017/S1351324916000243

Devlin, J., Chang, M.-W., Lee, K., Google, K. T., & Language, A. I. (2018). BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. *Naacl-Hlt 2019*, *Mlm*, 4171–4186. https://aclanthology.org/N19-1423.pdf

Ekaptiningrum, K. (2023). *Baru 2,8 Persen Masyarakat Indonesia Menyikat Gigi Secara Benar*. UNIVERSITAS GAJAH MADA. https://ugm.ac.id/id/berita/baru-28-persen-masyarakat-indonesia-menyikat-gigi-secara-benar/?utm_source=chatgpt.com

Eriksson, T., & Bill, D. (2023). *Fine-tuning a LLM using Reinforcement Learning from Human Feedback for a Therapy Chatbot Application SCHOOL OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE DESIRÉE BILL FINE-TUNING A LLM USING REINFORCEMENT LEARNING FROM HUMAN FEEDBACK*

FOR A THERAPY CHATBO.

Fitzpatrick, K. K., Darcy, A., & Vierhile, M. (2017). Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (Woebot): A randomized controlled trial. *JMIR Mental Health*, *4*(2), 1–11. https://doi.org/10.2196/mental.7785

Følstad, A., & Brandtzaeg, P. B. (2017). Chatbots and the New World of HCI. *Interactions*, *24*(4), 38–42. https://doi.org/10.1145/3085558

Gubareva, R., & Lopes, R. P. (2020). Virtual assistants for learning: A systematic literature review. *CSEDU 2020 - Proceedings of the 12th International Conference on Computer Supported Education*, *1*(Csedu), 97–103. https://doi.org/10.5220/0009417600970103

Himawati, M. (2023). Upaya Peningkatan Kesadaran Menjaga Kesehatan Gigi Dan Mulut di Wilayah Kerja Puskesmas Leuwigajah dengan Program Penyuluhan. *Jurnal Abdimas Kartika Wijayakusuma*, *4*(2), 130–136. https://doi.org/10.26874/jakw.v4i2.304

Hussain, S., Ameri Sianaki, O., & Ababneh, N. (2019). A Survey on Conversational Agents/Chatbots Classification and Design Techniques. In *Advances in Intelligent Systems and Computing* (Vol. 927, Issue March). Springer International Publishing. https://doi.org/10.1007/978-3-030-15035-8_93

Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert Scale: Explored and Explained. *British Journal of Applied Science & Technology*, *7*(4), 396–403. https://doi.org/10.9734/bjast/2015/14975

Jurafsky, D., & Martin, J. (2014). Speech and Language Processing. In *Speech and Language Processing.* (Vol. 3).

Kumar, P. (2024). Large language models (LLMs): survey, technical frameworks, and future challenges. In *Artificial Intelligence Review* (Vol. 57, Issue 9). Springer Netherlands. https://doi.org/10.1007/s10462-024-10888-y

Laranjo, L., Dunn, A. G., Tong, H. L., Kocaballi, A. B., Chen, J., Bashir, R., Surian, D., Gallego, B., Magrabi, F., Lau, A. Y. S., & Coiera, E. (2018). Conversational

agents in healthcare: A systematic review. *Journal of the American Medical Informatics Association*, *25*(9), 1248–1258. https://doi.org/10.1093/jamia/ocy072

Liddy, E. D. (2021). SURFACE at Syracuse University Natural Language Processing. *In Encyclopedia of Library and Information Science*. https://surface.syr.edu/istpub/63/

Mao, Y., Ge, Y., Fan, Y., Xu, W., Mi, Y., Hu, Z., & Gao, Y. (2024). *A Survey of Large Language Models*. 1–140. http://arxiv.org/abs/2407.11046

Maramis, J. L., Adam, J. Z., & Koch, N. M. (2023). Edukasi Pemeliharaan Kesehatan Gigi Dan Mulut Serta Pengolesan Tooth Mousse Untuk Pencegahan Karies Gigi Pada Murid Sd Inpres Malalayang Ii Kota Manado. *GEMAKES: Jurnal Pengabdian Kepada Masyarakat*, *3*(1), 33–40. https://doi.org/10.36082/gemakes.v3i1.1068

Matthew, R., Agustriawan, D., Bani, M. D., Sadrawi, M., Ratnasari, N. R. P., Firmansyah, M., & Parikesit, A. A. (2022). The Development of A Medical Chatbot Using the SVM Algorithm. *2022 4th International Conference on Cybernetics and Intelligent System, ICORIS 2022*, 1–6. https://doi.org/10.1109/ICORIS56080.2022.10031400

Maybury, C., Horowitz, A. M., La Touche-Howard, S., Child, W., Battanni, K., & Wang, M. Q. (2019). Oral health literacy and dental care among low-income pregnant women. *American Journal of Health Behavior*, *43*(3), 556–568. https://doi.org/10.5993/ajhb.43.3.10

McTear, M., Callejas, Z., & Griol, D. (2016). The conversational interface: Talking to smart devices. *The Conversational Interface: Talking to Smart Devices*, 1–422. https://doi.org/10.1007/978-3-319-32967-3

Nakashima, H., Aghajan, H., Carlos, J., & Wrede, A. (2010). Handbook of Ambient Intelligence and Smart Environments. *Handbook of Ambient Intelligence and Smart Environments*, *January*. https://doi.org/10.1007/978-0-387-93808-0

Palanica, A., Flaschner, P., Thommandram, A., Li, M., & Fossat, Y. (2019). Physicians' perceptions of chatbots in health care: Cross-sectional web-based

survey. *Journal of Medical Internet Research*, *21*(4). https://doi.org/10.2196/12887

Prasanti, D., & Indriani, S. S. (2018). Pengembangan Teknologi Informasi Dan Komunikasi Dalam Sistem E-Health Alodokter.Com the Use of Information and Communication Technology in E-Health System Alodokter.Com. *Jurnal Sosioteknologi*, *17*(1), 93–103. http://journals.itb.ac.id/index.php/sostek/article/view/6294

Pressman, R. S. (2000). *Software process*. https://doi.org/10.1145/336512.336521

Radford, A., Wu, J., Child, R., Luan, D., Amodei, D., & Sutskever, I. (2021). *On the Opportunities and Risks of Foundation Models*. http://arxiv.org/abs/2108.07258

Radziwill, N., & Benton, M. C. (2022). Evaluating Quality of Chatbots and Intelligent Conversational Agents of BCA (VIRA) Line. *Interdisciplinary Social Studies*, *1*(5), 532–542. https://doi.org/10.55324/iss.v1i5.122

Raffel, C., Shazeer, N., Roberts, A., Lee, K., Narang, S., Matena, M., Zhou, Y., Li, W., & Liu, P. J. (2020). Exploring the limits of transfer learning with a unified text-to-text transformer. *Journal of Machine Learning Research*, *21*, 1–67.

Ramadhan, A., Arifin, R., Hatta, I., Hamdani, R., & Dewi, N. (2023). HUBUNGAN PENGETAHUAN KESEHATAN GIGI DAN MULUT DENGAN KEHILANGAN GIGI DI WILAYAH KERJA PUSKESMAS SEMANGAT DALAM. *Dentin*, *7*. https://doi.org/10.20527/dentin.v7i3.10746

Royce, W. W. (2021). Managing the Development of Large Software Systems (1970). *Ideas That Created the Future*, *August*, 321–332. https://doi.org/10.7551/mitpress/12274.003.0035

Sabrina Putri, S., & Sofiani, E. (2023). *Peningkatan Pengetahuan Kesehatan Gigi dan Mulut Melalui Improving Dental and Oral Health Through Counseling on Students of Madrasah Ibtida ' iyah*. *8*(6), 947–953.

Santoso, C. M. A., Bramantoro, T., Nguyen, M. C., Bagoly, Z., & Nagy, A. (2020). Factors affecting dental service utilisation in indonesia: A population-based multilevel analysis. *International Journal of Environmental Research and Public*

Health, *17*(15), 1–11. https://doi.org/10.3390/ijerph17155282

Seeger, A. M., Pfeiffer, J., & Heinzl, A. (2018). Designing anthropomorphic conversational agents: Development and empirical evaluation of a design framework. *International Conference on Information Systems 2018, ICIS 2018*, *Oracle 2016*, 1–17.

Shum, H. yeung, He, X. dong, & Li, D. (2018). From Eliza to XiaoIce: challenges and opportunities with social chatbots. *Frontiers of Information Technology and Electronic Engineering*, *19*(1), 10–26. https://doi.org/10.1631/FITEE.1700826

Sinaga, A. P. I. (2022). Korelasi Disparitas Ketersediaan Tenaga Medis Gigi Antardaerah Terhadap Pemanfaatan Layanan Gigi dan Mulut di Indonesia. *Jurnal Manajemen Pelayanan Kesehatan (The Indonesian Journal of Health Service Management)*, *25*(03), 108–115. https://doi.org/10.22146/jmpk.v25i03.5879

Sommerville, I. (2011). *Software Engineering (9th ed.; Boston, Ed.). Massachusetts: Pearson Education.*

Strekalova, Y. A. (2014). Seekers and avoiders: Using health information orientation to explore audience segmentation. *Journal of Communication in Healthcare*, *7*(3), 228–237. https://doi.org/10.1179/1753807614Y.0000000058

Ye, J., Bronstein, S., Hai, J., & Hashish, M. A. (2025). *DeepSeek in Healthcare: A Survey of Capabilities, Risks, and Clinical Applications of Open-Source Large Language Models*. https://arxiv.org/pdf/2506.01257

Yu, S., Gu, C., Huang, K., & Li, P. (2024). Predicting the next sentence (not word) in large language models: What model-brain alignment tells us about discourse comprehension. *Science Advances*, *10*(21). https://doi.org/10.1126/sciadv.adn7744

Yunianto, T. K. (2023). Tertinggi di Asia, Kenaikan Biaya Medis RI 13,6% pada Tahun 2023. *Marketeers*, 1. https://www.marketeers.com/tertinggi-di-asia-kenaikan-biaya-medis-ri-136-pada-tahun-2023/