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Tackling Rural Healthcare Gaps: Intelligent Doctor Recommendation by Distil BERT with Coordinated Medicine Delivery

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ABSTRACT

In rural healthcare, patients often struggle to navigate complex medical systems, leading to misdirected consultations and treatment delays. Traditional paper-based clinics further exacerbate inefficiencies with crowded queues and poor emergency handling. Current digital solutions typically offer only basic appointment booking or generic disease prediction, failing to provide personalized guidance or integrate the complete patient journey. Our AI-powered platform addresses these gaps using a fine-tuned Distil BERT model that analyses patient-described symptoms and recommends appropriate medical specialities with 83.8% accuracy. The system seamlessly integrates intelligent doctor matching with a token-based queue management system, real-time emergency SOS alerts, and digital prescription generation. This creates a comprehensive, patient-centric workflow from initial symptom assessment through treatment completion. Future enhancements will incorporate multi-lingual support, voice-input capabilities, pharmacy integration, and telemedicine modules to further expand accessibility and create a complete healthcare ecosystem for underserved communities.

Keywords: *Healthcare Access, Rural Healthcare, Doctor Recommendation System, Distil BERT, Natural Language Processing, Symptom Classification, Real-time Alert System, Digital Prescription.*

I. INTRODUCTION

Healthcare accessibility in rural regions continues to be a pressing global concern. Patients in these areas encounter multiple challenges including confusion in selecting appropriate medical specialists, extensive waiting times due to manual appointment systems, and inadequate emergency response mechanisms. These inefficiencies often lead to delayed diagnoses, worsened medical conditions, and overall patient dissatisfaction. Current digital healthcare solutions primarily focus on basic appointment scheduling while lacking intelligent triage capabilities. Systems like Practo and similar platforms, while useful for urban settings, fail to address the fundamental need for initial medical guidance in resource-constrained environments. The absence of integrated emergency response features and comprehensive workflow management further limits their effectiveness in rural healthcare scenarios.

MediQueue+ addresses these limitations through a comprehensive web-based platform that combines artificial intelligence with real-time communication capabilities. Our system features:

i. AI-powered symptom analysis using fine-tuned DistilBERT model
ii. Token-based queue management system
iii. Real-time emergency SOS broadcasting
iv. Digital prescription generation
v. Secure doctor dashboard with live patient monitoring

Built on Flask web framework with SQLite database and Socket.IO for real-time updates, MediQueue+ represents a significant step toward automated, efficient healthcare delivery. This paper details the system architecture, implementation methodology, performance analysis, and future enhancement possibilities.

II. LITERATURE REVIEW

A. AI-Driven Patient Management and Doctor Recommendation Systems

Several recent studies highlight significant advancements in AI-powered healthcare management, particularly in doctor recommendation and patient triage systems. Hemkiran et al. (2024) [1] present a web-based patient health management platform that uses machine learning for doctor recommendations and medicine alternatives. Their work emphasizes the role of NLP-driven symptom classification and the integration of ML models for improved patient–doctor matching.

This aligns closely with modern AI systems that leverage text-based symptom descriptions as a primary input for automated specialty routing. Similarly, Yang and Wang (2020) [7, 8] propose a recommendation algorithm that incorporates both doctor quality metrics and patient preferences. Their approach demonstrates that hybrid systems combining machine learning with structured preference data can markedly improve recommendation accuracy and patient satisfaction. These studies collectively establish the groundwork for advanced doctor recommendation engines that balance efficiency, personalization, and accuracy.

B. Queue Management Systems in Healthcare

Kumar et al. (2024) [2] provide a systematic review of smart queue management systems, revealing that traditional manual queuing methods are often inefficient, prone to delays, and lacking transparency. Their synthesis of current queueing technologies—from token systems to real-time digital dashboards—highlights the growing adoption of automated patient flow systems. The study concludes that integrating queue management with real-time communication technologies can significantly reduce patient waiting times and enhance overall service quality. Such findings underpin the importance of token-based or automated queue workflows in modern digital clinics.

C. Deep Learning in Patient-Specific Healthcare

Chen et al. (2023) [3] offer a comprehensive review of deep learning applications tailored to patient-specific healthcare, encompassing diagnosis prediction, risk stratification, and personalized treatment planning. Their analysis underscores the effectiveness of advanced neural architectures such as transformers, CNNs, and RNNs in extracting clinically relevant patterns from both structured and unstructured data. Wang and Preininger (2023) [4] further contextualize the evolution of AI in healthcare, outlining its historical development forecasting future directions. These include the integration of multimodal data (text, imaging, lab records), improved model explainability, and ethical considerations. Together, these reviews reveal how deep learning has become foundational to modern medical AI, particularly in triage and decision-support systems.

D. Transformer-Based Models for Clinical Data

Multiple studies underscore the transformative impact of transformer architectures on clinical text processing and electronic health record (EHR) modeling.

i. DistilBERT, introduced by Sanh et al. (2019) [9], is a lightweight distilled version of BERT designed to maintain high language understanding performance while reducing computational overhead. Its efficiency makes it particularly suitable for real-time healthcare applications such as symptom classification and triaging—where speed and accuracy are both crucial.

ii. BERT, the foundational transformer model developed by Devlin et al. (2018) [12], established bidirectional contextual learning as a breakthrough in NLP. Its influence extends across nearly all medical NLP tasks, including clinical entity extraction, symptom recognition, and diagnosis prediction.

iii. ClinicalBERT, presented by Huang et al. (2019) [10], adapts BERT specifically for clinical notes, improving representation learning for medical terminology. This specialization significantly enhances performance on tasks such as readmission prediction and clinical text classification.

iv. Med-BERT, described by Rasmy et al. (2021) [5], extends transformer learning to large-scale structured EHR data, proving highly effective in disease prediction tasks. Its ability to model temporal clinical sequences is particularly valuable for chronic disease management.

v. BEHRT, developed by Li et al. (2020) [6], is another EHR-focused transformer noted for its capacity to capture long-term patient history patterns. Its architecture supports multi-label prediction and complex risk modeling, paving the way for advanced predictive healthcare systems.

E. Deep Learning and EHR-Based Healthcare Systems

Rajkomar et al. (2018) [11] demonstrate the scalability and accuracy of deep learning models trained on large EHR datasets. Their work shows that deep neural networks can outperform traditional models on tasks such as mortality prediction, length-of-stay estimation, and diagnosis forecasting. This study cemented the role of deep learning as a practical tool for real-world clinical settings, influencing many subsequent innovations in medical AI systems.

III. METHODOLOGY

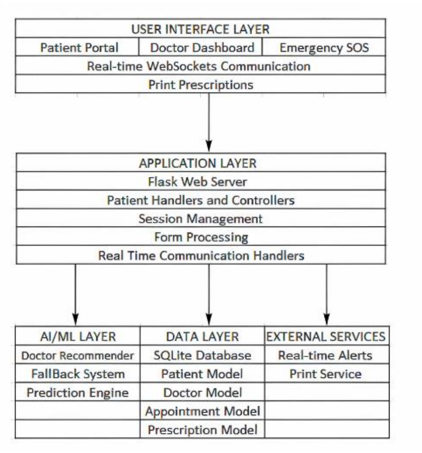

Fig. 1: System Architecture

A. AI-Powered Doctor Recommendation Engine

The core intelligence of MediQueue+ is driven by a fine-tuned DistilBERT model, chosen specifically for its impressive balance between computational efficiency and high-quality language understanding. The recommendation system was trained on a custom dataset of 6,000 medically relevant symptom descriptions, each manually annotated across 20 distinct medical specialties, ensuring comprehensive coverage of common and uncommon health concerns.

To enhance generalization and reduce overfitting, the training pipeline incorporated a variety of data augmentation techniques, including synonym replacement, contextual paraphrasing, and back-translation across multiple languages. These methods significantly improved robustness against noisy or ambiguous user inputs.

The training process was executed over 5 epochs, using a carefully tuned learning rate of 2e-5, balancing convergence speed and model stability. The final model achieved a validation accuracy of 83.8%, demonstrating reliable classification performance. To further enhance system reliability, a rule-based fallback engine supplements the AI model. This engine performs keyword extraction and specialty matching whenever the model's confidence score drops below 50%, ensuring the platform always provides users with a safe and meaningful recommendation.

B. Real-Time Appointment Management

The appointment scheduling workflow relies on a token-based queue management system, designed to provide fairness, transparency, and ease of use. When a patient registers, the system automatically assigns a sequential token number, representing their position in the consultation pipeline. Doctors can monitor real-time updates through their dedicated dashboards, which display the current queue status, upcoming patients, and any active consultation sessions.

C. Emergency SOS Alert System

For critical medical scenarios, MediQueue+ integrates an instant Emergency SOS Alert mechanism that allows patients to send urgent distress signals with a single tap. These alerts are immediately broadcast to all connected doctor dashboards using Socket.IO, ensuring minimal delay in communication.

Each alert is recorded in the system's backend with precise timestamps, patient identification, and any relevant contextual information. This creates a prioritized workflow where emergency cases automatically move ahead in the queue, guaranteeing that doctors can provide timely and potentially life-saving assistance.

D. Digital Prescription Module

The Digital Prescription Module empowers doctors to generate professional, structured, and printable prescriptions directly from their dashboard. The interface offers an intuitive form where doctors can specify medications, dosage instructions, usage frequency, treatment duration, and any additional clinical notes or follow-up recommendations.

All prescriptions are securely stored and linked to the corresponding patient appointment records, enabling quick retrieval for future reference. The system ensures consistency and reduces manual errors by enforcing structured input formats, ultimately improving the patient's continuity of care.

E. Doctor Dashboard & Security

To safeguard sensitive medical information, the platform employs a secure authentication framework fortified with session validation, encrypted data transmission, and access-controlled modules. Doctors must authenticate through a protected login system that prevents unauthorized entry and ensures user accountability.Once authenticated, doctors gain access to a comprehensive dashboard equipped with essential tools such as live queue monitoring, emergency alert handling, prescription creation, and appointment status management.

The dashboard's streamlined design ensures efficient navigation, enabling healthcare providers to focus on delivering quality medical care while the system manages the operational workflow securely and reliably.

IV. RESULTS

A. AI Model Performance

Table 1: Performance Comparison Table

Model	Accuracy	Precision	Recall
Logistic Regression	72.34%	71.89%	72.67%
K-Nearest Neighbors	75.12%	74.56%	75.89%
SVM	76.89%	76.23%	77.12%
Decision Tree	81.23%	80.45%	81.78%
Random Forest	83.55%	82.91%	83.34%
DistilBERT	83.80%	83.15%	83.72%

DistilBERT demonstrates superior performance with 83.80% accuracy, outperforming traditional models. While Random Forest shows competitive results at 83.55% accuracy, DistilBERT maintains a better balance with 83.15% precision and 83.72% recall.
This confirms DistilBERT's effectiveness in handling complex symptom-to-specialty mapping tasks for medical recommendations.

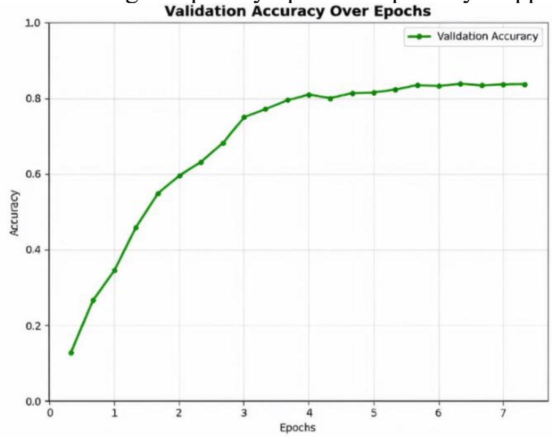

Fig. 2: Accuracy Graph

B. System Integration Testing

End-to-end workflow testing demonstrated seamless integration across all modules:

i. Doctor recommendation based on symptoms.
ii. Emergency alert delivery to doctor dashboards: < 2 seconds
iii. Prescription generation and storage: < 5 seconds
iv. Queue status updates: Real-time

C. User Interface Evaluation

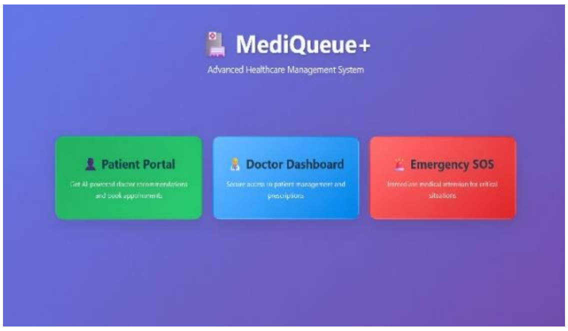

Fig. 3: Home Page

Fig. 4: Patient Dashboard

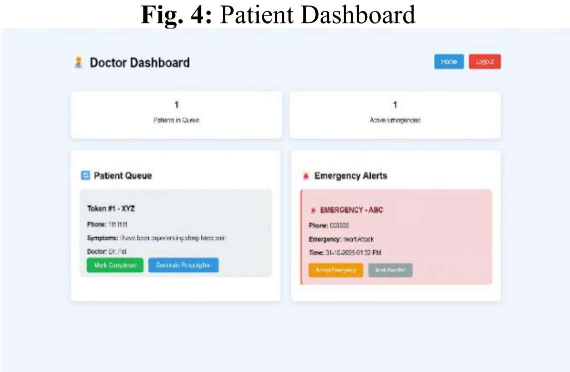

Fig. 5: Doctor Dashboard

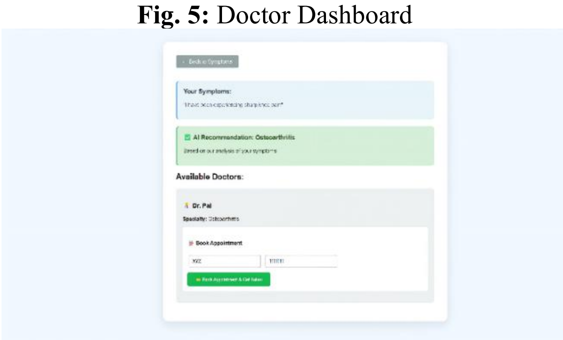

Fig. 6: Doctor Recommendation Interface

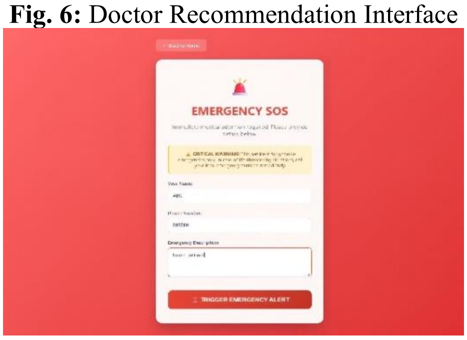

Fig. 7: Emergency Portal Interface

The patient dashboard (Fig. 4) features intuitive symptom input, while the doctor dashboard (Fig. 5) provides comprehensive patient management capabilities. The AI Doctor recommendation interface (Fig. 6) enables patients to be matched to right doctor. The Emergency Portal interface (Fig. 7) for emergency cases.

V. DISCUSSION

The 83.8% accuracy achieved by our DistilBERT model is particularly significant given the 20-class classification task and the challenge of interpreting layman's medical descriptions. The model demonstrated strong capability in handling symptom variations and medical terminology differences. The integration of real-time features through Socket.IO proved crucial for emergency response, with sub-2-second alert delivery ensuring prompt medical attention for critical cases. The fallback mechanism successfully handled approximately 12% of cases where AI confidence was insufficient, ensuring continuous system operation.

Challenges included initial low confidence predictions for serious conditions like stroke, which were mitigated through data augmentation and the implementation of confidence thresholds. The hybrid AI plus rule-based approach proved robust against model uncertainties.

VI. CONCLUSION

MediQueue+ represents a significant advancement in rural healthcare technology, successfully integrating AI-powered medical guidance with comprehensive clinic management features. The system demonstrates that lightweight transformer models like DistilBERT can effectively handle medical triage tasks while maintaining computational efficiency suitable for resource-constrained environments.

The real-time features, particularly the emergency SOS system and live queue management, address critical gaps in current healthcare solutions. The platform's patient-centric design ensures accessibility while maintaining clinical efficiency.

Future enhancements will focus on adding multi-lingual support for Hindi and regional languages, voice-based symptom input through speech-to-text technology, pharmacy integration for direct prescription fulfillment, telemedicine capabilities for remote consultations, predictive analytics for wait time estimation, and mobile application development for increased accessibility.

REFERENCES

Hemkiran, S., War, M. M., Aadhithiyan, K. S., & Kabilan, K. (2024). Web-based Patient Health Management System with doctor recommendations and Medicine Alternatives Using Machine Learning. 2024 International Conference on Smart Systems for Electrical, Electronics, Communication and Computer Engineering (ICSSEECC).

Kumar, A., Sharma, S., & Garg, N. (2024). Smart queue management systems in healthcare: A systematic literature review. Healthcare Technology Letters, 11(1), 45-52.

Chen, J., Li, K., Zhang, Z., et al. (2023). Deep learning for patient-specific healthcare: A comprehensive review. Artificial Intelligence in Medicine, 138, 102514.

Wang, F., & Preininger, A. (2023). AI in healthcare: past, present and future. Stroke and Vascular Neurology, 8(1), 1-10.

Rasmy, L., Xiang, Y., Xie, Z., Tao, C., & Zhi, D. (2021). Med-BERT: pretrained contextualized embeddings on large-scale structured electronic health records for disease prediction. NPJ Digital Medicine, 4(1), 86.

Li, Y., Rao, S., Solares, J. R. A., et al. (2020). BEHRT: Transformer for Electronic Health Records. Scientific Reports, 10(1), 7155.

Yang, Y., & Wang, X. (2020). A Doctor Recommendation Algorithm Based on Doctor Quality and Patient Preferences. Journal of Healthcare Engineering, 2020.

Yang, Y., & Wang, X. (2020). A Doctor Recommendation Algorithm Based on Doctor Quality and Patient Preferences. Journal of Healthcare Engineering, 2020.

Sanh, V., Debut, L., Chaumond, J., & Wolf, T. (2019). DistilBERT, a distilled version of BERT: smaller, faster, cheaper and lighter. arXiv preprint arXiv:1910.01108.

Huang, K., Altosaar, J., & Ranganath, R. (2019). ClinicalBERT: Modeling Clinical Notes and Predicting Hospital Readmission. arXiv preprint arXiv:1904.05342.

Rajkomar, A., Oren, E., Chen, K., et al. (2018). Scalable and accurate deep learning with electronic health records. NPJ Digital Medicine, 1(1), 18.

Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2018). BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. arXiv preprint arXiv:1810.04805.