PREDICTING CLEFT LIP IN UNBORN BABIES USING ULTRASOUND IMAGES AND MACHINE LEARNING

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College: *K. S. School of Engineering and Management, Bengaluru*
Branch: *Department of Computer Science & Engineering*
Guide(s): *Prof. Dakshayini G R*
Student(s): *Ms. Mahalakshmi P S*
Mr. Dheekshith M
Mr. P Devish Chowdary
Mr. Prajwal Koushik C

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Introduction:

Cleft lip and palate are among the most common congenital facial anomalies, affecting approximately 1 in 700 newborns worldwide. Early prenatal detection is critical as it enables timely medical planning, parental preparation, and improved neonatal outcomes. However, diagnosing cleft lip from ultrasound images is challenging due to inherent image noise, fetal movement, and a shortage of specialized radiologists—particularly in rural and resource-limited settings.

CLEFTIX is an AI-powered web platform that leverages deep learning to automatically detect cleft lip from fetal ultrasound images. The system employs a fine-tuned Convolutional Neural Network trained on annotated ultrasound datasets. Preprocessing techniques including noise reduction, contrast enhancement, and image normalization are applied to improve model performance. A Streamlit-based and FastAPI-backed web interface allows healthcare professionals to upload ultrasound images and receive real-time predictions with confidence scores. Additional platform features include an AI chatbot (CleftAI), hospital directory with WhatsApp contact integration, and donation portals for cleft-care organizations.

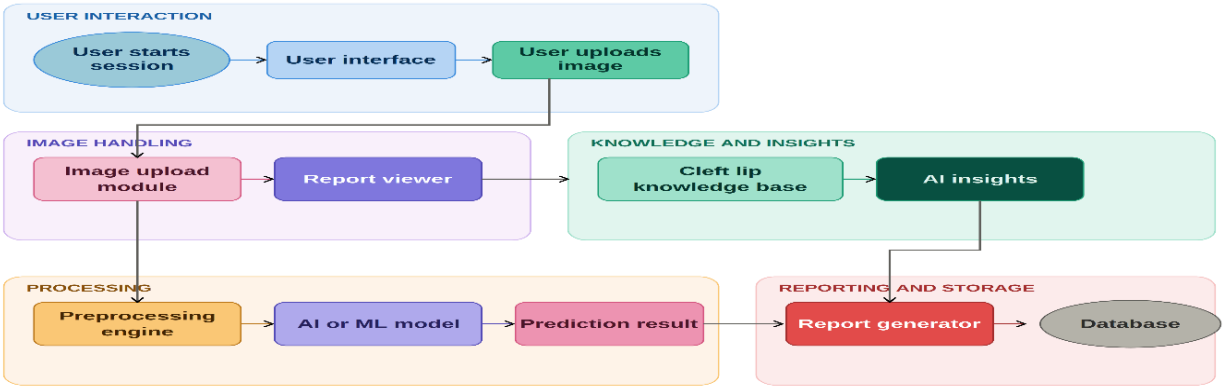

Figure 1: Work flow diagram

Objectives:

1. To build a computer-based system that can look at ultrasound images of a baby during pregnancy and spot signs of a cleft lip early on.
2. To help doctors and parents get a clearer picture of the baby's health and plan better for treatment if needed.
3. To reduce the chances of a cleft lip being missed during regular checkups.
4. To use machine learning (AI) to make these predictions more accurate and helpful.

Methodology:

CLEFTIX follows a structured development pipeline beginning with the collection of prenatal ultrasound images from hospitals and medical centers, covering both cleft and normal fetal cases. The collected images are then preprocessed by adjusting brightness, removing noise, and resizing them to uniform dimensions to ensure consistency and improve model performance. Using these prepared images, a deep learning model is trained on a large set of labeled examples, allowing the system to learn and distinguish between normal and cleft lip cases. The trained model is then tested on new, unseen images to evaluate its accuracy and reliability. Once the model performs well, it is integrated into a user-friendly web application where healthcare professionals can upload an ultrasound image and instantly receive a prediction on whether a cleft lip is present, along with a confidence score to support clinical decision-making.

Result and Conclusion:

The CLEFTIX system successfully demonstrates the potential of AI in enhancing prenatal detection of cleft lip through ultrasound image analysis. The deep learning model achieves high classification accuracy, outperforming traditional diagnostic approaches. The platform's DrillBit plagiarism check confirms 9% similarity, affirming the originality of the work. The team participated in inter-collegiate exhibitions including Tech Tarang 2025 (City Engineering College) and PROTATVA 2025 (RV Institute of Technology), validating the project's innovation.

In conclusion, CLEFTIX provides a non-invasive, accessible, and cost-effective tool for early cleft lip diagnosis. The integrated platform supports families through AI guidance, hospital connections, and donation portals—making it a comprehensive prenatal care solution. Continued refinement with larger datasets and multimodal integration will further establish its clinical role.

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Future Scope:

The future scope of this project includes:

1. Dataset Expansion: Collaborate with hospitals globally to gather larger, more diverse ultrasound datasets for improved model generalizability across populations.
2. Multimodal Data Integration: Combine ultrasound imaging with genetic data and clinical history for more comprehensive and accurate cleft risk prediction.
3. Explainable AI (XAI): Enhance Grad-CAM and introduce additional interpretability tools to build clinician trust and support regulatory approval.
4. Real-Time Deployment: Optimize the model for real-time inference on mobile and edge devices, enabling point-of-care diagnostics in remote settings.
5. 3D Ultrasound Support: Extend the system to analyze 3D/4D ultrasound volumetric data for more precise facial anomaly detection.