

IoT-Enabled Face Recognition Attendance Systems for University Students in Sri Lanka

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Abstract

This study presents a comprehensive face recognition attendance system designed for educational institutions in Sri Lanka. The system leverages InsightFace's buffalo_L model as the primary recognition engine, achieving 99.83% accuracy for the LFW dataset. Our implementation addresses critical regional challenges, including limited technical expertise, budget constraints, diverse camera hardware availability, and offline operation requirements. The system architecture features automatic face detection and alignment, multi-image user registration with embedding averaging, a professional Flask-based web interface, and comprehensive camera support, including USB cameras, IP cameras, mobile devices, and IoT camera modules. Key innovations include intelligent camera management with automatic detection and troubleshooting guidance, a hybrid architecture combining production-grade InsightFace recognition with optional custom model training, and progressive enhancement that functions with basic hardware. Performance evaluation demonstrated sub-second response times. The complete IoT system is functional across Raspberry Pi, cloud computers and esp32cam embedded devices. As for the optional custom models, the accuracy scores were 3.9%, 1%, and 93% for CNN, the custom embedding model, and the embedding model with LogisticRegression, respectively. This work contributes to ICT Innovation and Emerging Technologies by providing accessible, production-ready technology solutions that enable the broader adoption of advanced computer vision technologies in educational settings. The open-source implementation facilitates knowledge transfer and local adaptation, supporting regional ICT capacity-building initiatives essential for developing country institutions. The system addresses post-pandemic requirements for contactless attendance management while maintaining deployment simplicity and operational reliability, which are suitable for resource-constrained environments.

Keywords: Face Recognition, IOT, Insightface embedding, CNN model, Cloud computing