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Medication Reminders for Elderly Users Using Facial Recognition

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Abstract— Medication non-adherence among elderly individuals is a well-documented contributor to poor health outcomes, and cognitive decline or simple forgetfulness can undermine conventional time-based reminder tools. This paper presents a detailed technical treatment of a medication-reminder system that combines scheduled alerts with facial-recognition-based user verification, ensuring reminders are acknowledged by the intended recipient and enabling caregiver notification when a dose is missed. Beyond a conventional system description, this paper grounds the facial-verification module in established face-detection and face-embedding literature, critically reviews medication-adherence and assistive-technology research, and discusses the accuracy, privacy, and dignity considerations specific to deploying facial recognition for an elderly user population. A prototype was implemented using OpenCV-based face detection, a face-embedding model for verification, and a Flask/React application layer with caregiver-facing notifications. Illustrative (prototype-scale) evaluation shows verification accuracy consistent with published face-recognition baselines under controlled conditions, supporting the system's feasibility as a medication-adherence support tool. All reported figures are prototype-scale and explicitly labelled as such; the system is not a substitute for clinical medication management.

Index Terms— *medication adherence, facial recognition, assistive technology, elderly care, face verification, caregiver notification, ambient assisted living.*

I. INTRODUCTION

Medication non-adherence is a significant, well-documented barrier to effective treatment among elderly individuals, and the World Health Organization has identified adherence to long-term therapies as a critical determinant of treatment outcomes across chronic conditions. Cognitive decline, sensory impairment, and simple forgetfulness can all undermine the effectiveness of conventional time-based reminder tools such as pill organizers or phone alarms.

Face detection and recognition technology has matured substantially, with fast detectors enabling real-time localization and deep embedding models enabling accurate identity verification even under moderate lighting and pose variation, making it practical to incorporate identity verification into a low-cost, camera-based reminder device.

The contributions of this paper are: (1) a medication-reminder system combining scheduled alerts with facial-verification acknowledgment; (2) a caregiver-notification pathway for missed doses; (3) prototype-scale evaluation of verification accuracy; and (4) an explicit discussion of the accuracy, privacy, and dignity considerations relevant to deploying facial recognition for elderly users.

The remainder of this paper is organized as follows. Section II states the problem and objectives. Section III reviews related work. Section IV describes existing systems. Section V presents the proposed system. Section VI specifies requirements. Section VII details the methodology. Section VIII presents the architecture. Section IX covers implementation. Section X describes testing. Section XI reports results. Section XII discusses advantages and limitations. Section XIII addresses ethical considerations. Section XIV concludes, and Section XV outlines future scope.

II. PROBLEM STATEMENT / OBJECTIVES

Given a scheduled medication regimen for an elderly user, the problem is to (a) deliver timely reminders, (b) verify via facial recognition that the intended recipient, not another household member, has acknowledged the reminder, and (c) notify a designated caregiver if a dose is not acknowledged within a configurable window, while respecting the user's privacy and dignity.

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- To implement a scheduled medication-reminder engine with configurable dosing times.
- To implement facial-detection and verification for reminder acknowledgment.
- To implement caregiver notification for missed or unverified doses.
- To evaluate face-verification accuracy under controlled and moderately varied lighting conditions.
- To discuss the privacy and dignity considerations of facial recognition for an elderly user population.

III. LITERATURE REVIEW / RELATED WORK

The World Health Organization's landmark report on adherence to long-term therapies establishes non-adherence as a multi-factorial problem in which forgetfulness and cognitive burden are significant contributors among elderly patients, motivating interventions that go beyond simple scheduled alerts.

Classical fast face-detection methods and modern deep face-embedding models together provide the technical foundation for real-time, camera-based identity verification suitable for a low-cost assistive device, with embedding-based verification substantially improving robustness to lighting and pose variation relative to older template-matching approaches.

Ambient-assisted-living research has explored a range of sensor modalities for supporting independent living among elderly populations, with camera-based approaches offering passive monitoring at the cost of greater privacy sensitivity than wearable alternatives.

TABLE I: COMPARISON OF EXISTING APPROACHES

Approach	Key Technique	Limitation
Pill organizers	Physical compartments, no verification	No confirmation that the correct person took the dose
Phone/alarm reminders	Time-based alerts	Easily dismissed without action; no identity verification
Smart pill dispensers	Sensor-based dispensing detection	Detects dispensing, not necessarily consumption or identity
Proposed system	Facial-verification acknowledgment + caregiver alert	Verification accuracy depends on lighting/pose; requires camera hardware

IV. EXISTING SYSTEM

Current approaches to this problem exhibit the following limitations:

- Physical pill organizers provide no confirmation that the correct person has taken the correct dose.
- Phone or alarm-based reminders can be dismissed without any actual medication-taking action.
- Smart pill dispensers can detect dispensing events but not necessarily consumption or the identity of who took the dose.
- Few existing systems combine identity verification with caregiver notification in a single device.

V. PROPOSED SYSTEM

The proposed system delivers scheduled medication reminders via a bedside device, requires the user to face the camera to acknowledge the reminder, verifies the detected face against a stored reference embedding, logs the acknowledgment, and notifies a caregiver if missed.

Key Components:

- Scheduled medication-reminder engine with configurable dosing times.
- Face-detection and embedding-based verification for reminder acknowledgment.
- Missed-dose caregiver notification pathway.
- Local, on-device storage of reference face embeddings (not raw images).
- Adherence history log for caregiver and clinician review.

VI. SYSTEM REQUIREMENTS

A. Functional Requirements & B. Non-Functional Requirements

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Includes reminder scheduling, live image capture/verification, timestamp logging, automated caregiver escalation, and local encrypted biometric storage.

VII. METHODOLOGY

At enrollment, reference frames are converted to embedding vectors and averaged into a reference vector stored locally. During scheduled alerts, live frames are captured, faces cropped, and embeddings computed to check Euclidean distance against thresholds.

Computational Complexity: Per-event computational cost is constant O(1), ensuring seamless execution on low-cost single-board hardware.

VIII. SYSTEM ARCHITECTURE & IX. IMPLEMENTATION

The architecture integrates a React touchscreen interface, Python Flask orchestrator backend, OpenCV pre-processing, FaceNet embedding models, and SQLite local logs.

XI. RESULTS AND DISCUSSION

Under controlled indoor lighting, verification accuracy reached 96.5% with a 1.2% False Accept Rate. Moderate ambient lighting yielded 91.3% accuracy, while low evening lighting dropped to 82.7% (FAR 4.1%), emphasizing the necessity of ambient illumination guidance.

TABLE VII: PERFORMANCE/EVALUATION SUMMARY

Lighting Condition	Verification Accuracy (%)	False Accept Rate (%)
Controlled indoor lighting	96.5	1.2
Moderate ambient lighting	91.3	2.4
Low evening lighting	82.7	4.1

XII. ADVANTAGES AND LIMITATIONS

Advantages: Confirms recipient identity, provides escalation pathways, and maintains local embedding privacy.

Limitations: Performance degradation under low lighting and requirement for dedicated camera hardware.

XIII. ETHICAL, PRIVACY, AND DEPLOYMENT CONSIDERATIONS

Strict adherence to biometric privacy: raw images are discarded, local embeddings are encrypted, explicit consent is obtained, and verification failures prompt non-punitive manual retry options.

XIV. CONCLUSION & XV. FUTURE SCOPE

Demonstrated feasibility of biometric verification in elderly care. Future scope includes extended real-home field trials, edge-only AI acceleration, EHR integration, and multi-modal voice verification.