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Health Monitoring for Stroke Patients Using Machine Learning

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Abstract - Stroke patients often face challenges in communication and independent medication management, necessitating innovative assistive technologies for better healthcare monitoring. This project introduces a real-time hand gesture-based system to monitor tablet intake in stroke patients using computer vision and machine learning techniques. The solution integrates OpenCV for video processing, Media Pipe for accurate hand landmark detection, and Twilio for sending automated SMS alerts to caregivers. The system operates by detecting specific hand gestures-particularly the movement of the index finger toward the mouth-which signifies an attempt to consume medication. When this gesture is confirmed, the system logs the event, updates the tablet count, and triggers both a visual alert using Tkinter and an SMS notification via Twilio. This ensures real-time tracking and caregiver awareness without physical intervention. This low-cost, non-invasive solution can be implemented using a standard webcam and basic hardware, making it especially suitable for home healthcare environments. The methodology enhances patient autonomy while maintaining safety and accountability. Future developments may incorporate deep learning for more robust gesture recognition and extend the system's functionality to cover broader health monitoring scenarios.

***Key Words**: Hand Gesture Recognition, Stroke Patient Monitoring, Computer Vision, Real-time Alert System.*

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1. INTRODUCTION

Stroke is a critical medical condition that occurs when the blood supply to a part of the brain is interrupted or reduced, preventing brain tissue from receiving oxygen and nutrients. As a result, brain cells begin to die within minutes. Stroke is one of the leading causes of death and long-term disability worldwide. Survivors often experience serious physical and cognitive impairments, including paralysis, difficulty speaking, memory problems, and loss of coordination. These challenges severely affect their quality of life and ability to live independently. Monitoring the health and daily activities of stroke patients is essential for effective rehabilitation and preventing further complications. However, traditional healthcare systems often rely heavily on manual monitoring and periodic check-ups, which may not be sufficient for early detection of issues or providing timely assistance in emergencies. This gap creates an urgent need for smart, automated, and real-time health monitoring solutions.

Medication adherence is a critical aspect of patient care, especially for elderly individuals and those recovering from neurological conditions such as stroke. Missed or incorrect dosages can lead to severe health complications, hospital readmissions, and increased healthcare costs. Traditional methods of monitoring, such as caregiver supervision or manual tracking, are often unreliable or impractical for continuous observation. In response to this challenge, we present an automated tablet ingestion monitoring system based on computer vision and real-time gesture recognition.

This system employs a standard webcam and leverages Media Pipe's hand and face landmark detection frameworks to track specific movements indicative of tablet intake—particularly the motion of the hand approaching the mouth. A time-based confirmation logic ensures that the gesture is sustained for 0 to 5 seconds before verifying ingestion. Once confirmed, the system captures an image for documentation and instantly sends an SMS alert via the Twilio API to notify caregivers or family members. Additionally, all confirmed events are logged and stored with a timestamp, creating a verifiable digital record. This solution offers a non-invasive, cost-effective, and scalable approach to remote patient monitoring, making it highly applicable in-home care setups, elder care facilities, and

rehabilitation centres, where continuous oversight is essential but human supervision is limited.

2. METHODOLOGY

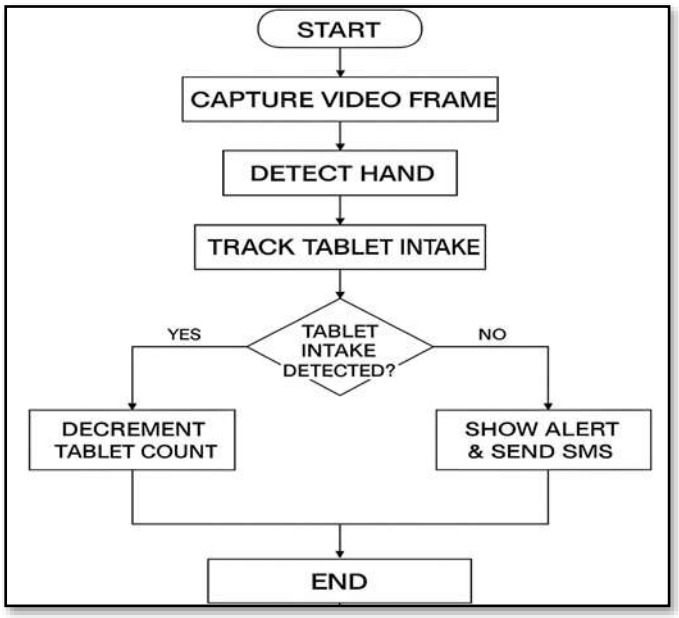

Fig 1: Flowchart On Tablet Intake Detected

This project introduces a vision-based tablet intake monitoring system designed to assist stroke patients by detecting hand-to-mouth gestures and notifying caregivers in real time. The system utilizes Python along with OpenCV for video input and processing, Media Pipe for accurate hand landmark detection, Tkinter for graphical notifications, and Twilio for SMS alerts. The system begins by capturing live video from a webcam using cv2.VideoCapture(0), with each frame converted from BGR to RGB to comply with Media Pipe's input requirements. These preprocessed frames are then analyzed using Media Pipe's hand tracking model, which identifies 21 hand landmarks. Key coordinates-specifically the WRIST and INDEX_FINGER_TIP-are extracted to monitor hand movement. A gesture is recognized as a tablet intake attempt when the index finger moves above the wrist (i.e., index_y < wrist_y), indicating a motion toward the mouth. A timer is used to confirm the duration of the gesture, and once the hand moves back down, the system confirms the intake. Upon confirmation, the tablet count is reduced, a Tkinter popup displays the updated status, and a Twilio SMS is sent to the caregiver. The system continues monitoring until all tablets are consumed, at which point a final popup and SMS are triggered stating that all tablets have been taken. Additionally, the user can manually exit the system using the ESC key. This automated, non-invasive solution promotes greater independence for stroke patients while ensuring caregivers remain informed.

3. WORKING PRINCIPLE

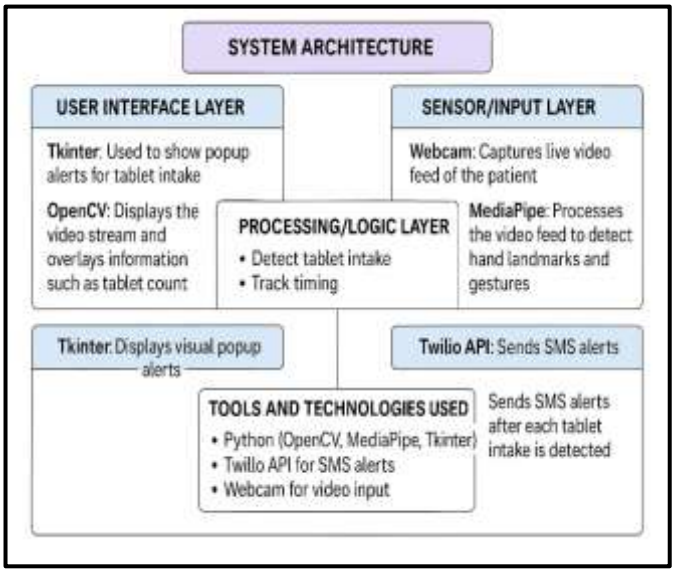

Fig.2: System Architecture

The working of the proposed tablet intake monitoring system begins with the initialization phase, where the webcam is activated using OpenCV, and the Media Pipe Hands module is initialized with defined detection and tracking confidence levels to ensure accurate hand gesture recognition. Additionally, the Twilio client is configured with account credentials to enable SMS communication, and the initial tablet count is set (e.g., TOTAL_TABLETS = 10). In the real-time video processing stage, each frame captured from the camera is converted from BGR to RGB, as Media Pipe requires RGB input. Media Pipe then analyzes the frame to detect hands and extract key landmarks, particularly the wrist and index finger tip, which are crucial for identifying the hand-to-mouth gesture.

Gesture detection is performed by comparing the y-coordinates of the wrist and the index finger tip. If the index finger tip is positioned higher than the wrist, the system interprets this as a potential hand-to-mouth gesture, signifying a tablet intake attempt. A timer is initiated to confirm the gesture's intentionality and duration. When the hand returns to a lower position, the system recognizes the gesture as complete. Upon confirmation, the duration is calculated, the remaining tablet count is decremented, and a visual confirmation is displayed using Tkinter. Simultaneously, an SMS alert is sent to a pre-registered caregiver via Twilio, keeping them informed of the patient's medication intake.

The system provides continuous feedback by displaying the remaining tablet count directly on the video feed, enabling real-time monitoring. It continues to observe for further

intake gestures until either all tablets have been consumed-prompting a final notification or the user manually exits the system by pressing the ESC key. This approach ensures stroke patients can manage their medication with minimal intervention while keeping caregivers actively informed.

4. RESULTS

The proposed system was implemented using a standard laptop webcam, Python, OpenCV, Media Pipe, and Twilio API. The system was tested under various scenarios to assess its functionality, responsiveness, and reliability in real-world conditions.

Example Output

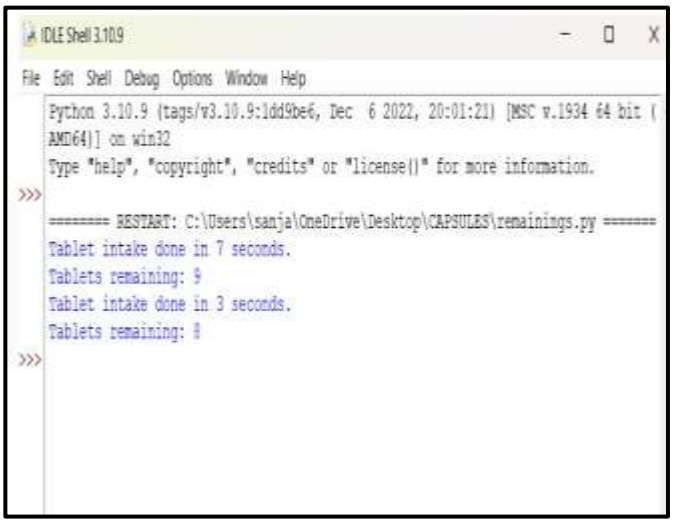

Fig 3: Program Output

- Console Output:

```
Tablet intake done in 3 seconds.
Tablets remaining: 9
```

- Tkinter Alert:

```
Title: Tablet Alert
Message: Tablet intake done in 3 seconds. Tablets remaining: 9
```

- SMS Message Sent:

```
Tablet intake done in 3 seconds.
Tablets remaining: 9
```

Functional Outcome

Functionality	Observed Outcome
Hand detection accuracy	Successfully detected hands in most lighting conditions.
Gesture recognition (hand-to-mouth)	Accurately detected the hand raising above the wrist as a tablet intake.
Tablet count tracking	Correctly updated and displayed remaining tablet count in real-time.
Visual alerts (Tkinter)	Displayed pop-up alerts after each tablet was detected as consumed.
SMS notifications (Twilio)	Sent real-time SMS to caregiver upon each tablet intake.
System termination	Stopped when all tablets were consumed or ESC was pressed.

Table 1: Summary of observed outcome.

5. CONCLUSIONS

This project successfully demonstrates an intelligent, low-cost, and non-intrusive system for monitoring tablet intake in stroke patients using computer vision and machine learning techniques. By integrating Media Pipe for real-time hand gesture detection, OpenCV for camera input and display, and Twilio for SMS-based caregiver alerts, the system addresses a critical healthcare need — ensuring medication adherence for patients with limited physical and cognitive ability. The approach eliminates the need for expensive wearable devices or constant supervision. It empowers stroke patients to manage medication intake independently, while also keeping caregivers informed. The hand-to-mouth gesture recognition mechanism proved effective in identifying intake events under normal lighting and camera conditions. The system not only improves patient safety but also reduces caregiver workload, making it highly suitable for home-based stroke rehabilitation scenarios.

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