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Monitoring Coma Patients in Real Time Using a Visual Perception System

Dr. Heena Kousar[1], Divya U H[2], Nithyananda C R[3], Dr. Chandramouli H[4], Dr. Rajani K C[5] , Dr. N P Nethravathi[6]
[1]Professor, Department of Computer Science and Engineering, East Point College of Engineering and Technology, Bangalore, India. heena.k@eastpoint.ac.in
[2]Assistant Professor, Department of Computer Science and Engineering, East Point College of Engineering and Technology, Bangalore, India. drchandramouli.h@eastpoint.ac.in
[3]Associate Professor,, Department of Computer Science and Engineering, East Point College of Engineering and Technology, Bangalore, India. nithyananda.cr@eastpoint.ac.in
[4]Professor, Department of Computer Science and Engineering, East Point College of Engineering and Technology, Bangalore, India. drchandramouli.h@eastpoint.ac.in
[5]Associate Professor, Department of Computer Science and Engineering, East Point College of Engineering and Technology, Bangalore, India. rajanikcc009@gmail.com
[6]Professor, Department of Computer Science and Engineering (Internet of Things and Cyber Security including Block Chain Technology, School of Computer Science and Engineering, Bangalore, India. nethravathi.np@reva.edu.in

Abstract: *Monitoring Coma Patients in Real Time using a Visual Perception System aims to revolutionize patient care in critical medical settings by providing an innovative, non-invasive, and continuous monitoring solution tailored specifically for coma patients. The system utilizes cameras and computer vision techniques to monitor and track recovery signs monitored around the clock, tracking indicators such as eye blinks, lip movements, etc. The combination of YOLOv8 and machine learning enabled us to create a system that instantaneously notifies caregivers. This instant notification system reduces the need for constant manual checks and optimizes smart responsive critical care.*
Keywords: *You Only Look Oncev8 (YOLOv8), Open Source Computer Vision Library (OpenCV), Internet of Things (IoT), Augmented Reality (AR), Cross Stage Partial Network (CSPNet), FPN (Feature Pyramid Network), PANet (Path Aggregation Network), Vision Transformers (ViT).*

1. INTRODUCTION

Coma is perhaps the most difficult state one can manage within critical medicine. Coma is a state of unconsciousness in which a patient does not exhibit any behavioral response to internal or external stimuli. This results from severe brain damage along with other health complications. While basic autonomic functions like heartbeat and breathing continue, these patients do not exhibit any voluntary responses which make non-stop and precise measuring critical in identifying early signs of improvement neurologically or complications. Such monitoring is primarily based on bedside clinical listening, visual scanning, and Electroencephalogram (EEG) interpretation. [6] highlighted the blinking of eye using facial landmarks using modified Eye Aspect Ratio to assess closeness of eye and efficiency of detection is improved.

In any case, such practices require highly trained personnel who are alert 24/7, which is not always feasible in today's resource-deprived hospitals facing staff shortages. To overcome these challenges, we developed a new non-invasive solution, the real-time coma patient monitoring system based on a visual perception system, which aims to autonomously track and evaluate coma patients with computer vision and AI. The system utilizes real-time video processing using OpenCV to recognize and analyze small physiological gestures such as blinks, lip movements, and other ocular twitches that signal recovery or an onset of neurological activity. autonomous nature of the system minimizes dependence on human oversight and reduces observation errors that can occur due to fatigue.

For instance, caregivers can receive alerts through SMS notifications, allowing for timely medical action when significant movements are detected. Face feature recognition to a video stream, its fast processing, and the robustness to noisy video data were some of the technical issues this system faced. For removal of background noise, MediaPipe Face Mesh was used, and eye and lip landmarks were detected using YOLO v8.

Machine learning tools were used on the data to predict probable alterations in the neurological condition of the patients. Spontaneous detection of eye movements was shown on several subjects, and while the

detection rate and processing speed were suboptimal at first, the system was subsequently shown to have the capacity to detect eye movements in real-time, which is encouraging.
The search software targets the integration of sophisticated machine vision systems and critical care service requirements. Aside from providing relief to overwhelmed healthcare providers, the system provides a far more extensive degree of monitoring without increased staffing cost that facilitates improving coma patient outcomes. This paper details the system architecture, technical methodologies, experimental results, and future directions for this work.

2. LITERATURE REVIEW

A substantial amount of research has examined technologies for automating critical care and monitoring coma patients.To lessen the need for manual supervision, the authors of [1] suggested an Internet of Things-based Smart Health Monitoring System for Coma Patients.Although the system used a variety of sensors to track vital signs, its design severely limited patients' comfort and mobility by requiring them to stay attached to big machines.Additionally, the system's data preprocessing flaws made it less accurate at identifying subtle patient responses like lip movements or eye blinks.
These drawbacks emphasize the necessity of non-invasive substitutes and more accurate data processing. An Internet of Things (IoT)-based coma patient monitoring system was presented in [2]. It included several wearable sensors to collect and transmit vital signs to a cloud server. Although remote and graphical analysis of data was possible, the extensive sensor setup made this approach bit expensive, As a result of this, the patients required heavy equipment attachments, frequent bed confinement impacted patient care. To ensure private data handling from body-area sensors, the author proposed a Patient Monitoring system augmented with blockchain technology that features a Patient Centric Agent to manage data privacy.
To provide patient data access to the medical staffs, the architecture employed a communication protocol. To assure privacy, the system’s data flow produced network traffic, raising concerns about real-time hospital deployment scalability. Focusing on the detection of clinical deterioration, the authors proposed a technique for hospitalized patients based on deep learning. Still dependent on pat-centric monitoring, the system limited even morewhich again limited patient comfort, even though it showed improved performance. Due to data preprocessing methods, the system still used sensor-based monitoring which stifled patient comfort.
As well as this demonstrated a wearable health monitoring system using a health Gaussian Process. In the study, the challenges were emphasized. For patients, static and bulky systems tend to dominate primary health monitoring, which offers no accurate real-time data streamed health information.
Despite these assumptions, the authors were in full support of advanced wearable devices. The range of current methods suffers from expensively implemented inaccurate detection of neurological signs. With a camera-based non-contact approach to patient monitoring, we have real-time coma patient monitoring utilizing a visual perception system which achieves watching coma patients without restrictions using computer vision and machine learning, filling these gaps. While improving the quality of care provided, our focus is to ease the technological burden on healthcare facilities. Haar cascade classifier method [5] used for facial recognition system which analyzes and tests for face recognition In [3], the author highlights a significant gap in the development of cost –effective IOT based monitoring system with resource constrained environment while being cost effective. But the limitation is it requires internet access with medical expensive which is problematic in developing countries with limited infrastructure and resources which initiates a more adaptable and robust solution for monitoring patient continuosly.

3. Overview of Real Time Coma Patient Monitoring Using Visual Perception System

Monitoring Coma Patient in Real time using Visual Perception System is designed to provide continuous, non-invasive monitoring of coma patients by utilizing advanced computer vision techniques. The system placing cameras to capture video of the patient’s face and upper body. This setup reduces patient discomfort while enabling constant surveillance. [4] proposes 3 modules for detecting facial paralysis i,e facial measure computation, facial paralysis classification and facial landmark extraction which provides a standardized tool for assessment in medical and monitoring patient with facial paralysis
The captured video is processed with OpenCV and YOLO v8. Facial features are detected using MediaPipe Face Mesh which improve detection accuracy, efficiency and further enhances image clarity with 468 facial landmarks,

Dlib has also been added to the system for fine-grained tracking of facial landmarks so that microscale movements like eyelid fluttering, eye blinking, and lip movement — all indicators of possible consciousness or neurological recovery — can be captured. A distinguishing characteristic of this system is automation. The system is fully automated and does not require external intervention. Furthermore, the system automates alerting and can send movement-triggered SMS alerts to alarms set by doctors and family members. This leads to a prompt response to possible recovery or distress signs, improving patient care and clinical workload alleviation. The system approach contrasts traditional EEG-based/sensor-rich monitoring systems that utilize high-positional attachments and bulky-cost setups by being affordable and entirely contactless. This approach vastly increases patient mobility and comfort, ideal for non-stop monitoring in intensive-care settings.

To evaluate its performance, the system was tested in a simulated hospital room environment. Controlled scenarios were used to mimic real-world patient conditions, allowing the team to validate the accuracy and responsiveness of the system. Initial results were promising, with the system successfully detecting programmed facial movements and issuing timely alerts. Although not yet flawless, the prototype demonstrates a substantial advancement toward intelligent, compassionate, and efficient care for coma patients.

4. Tools Used for Real Time Coma Patient Monitoring Using Visual Perception System

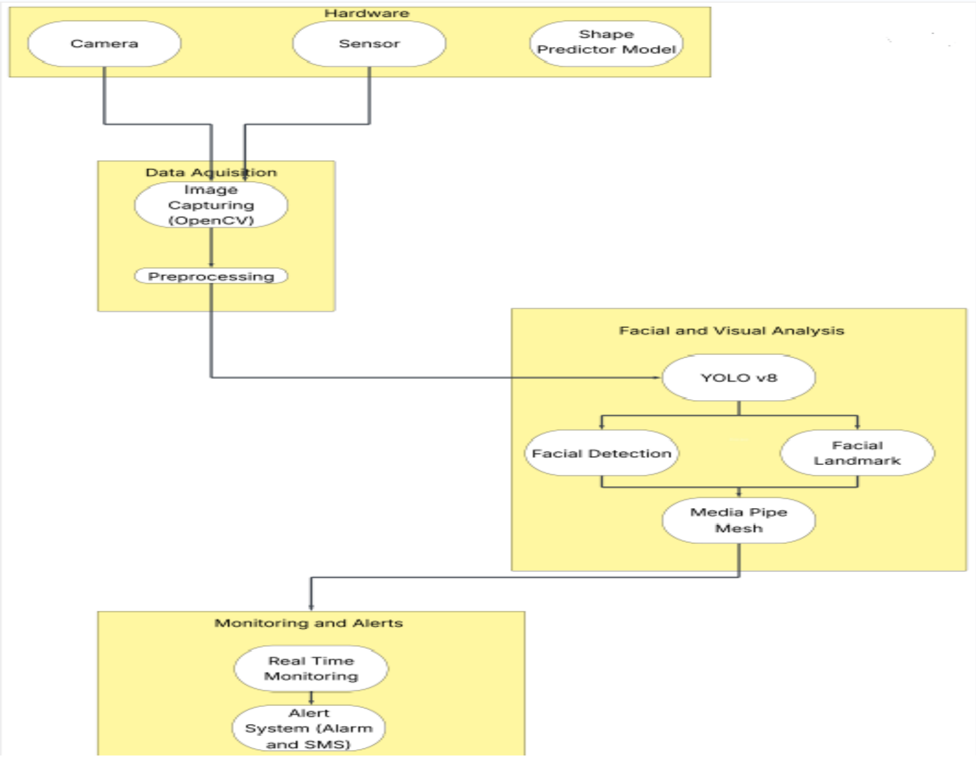

Figure 1: Tools used for Real Time Coma Patient Monitoring Using Visual Perception System

Developing a reliable, real-time, and non-invasive monitoring system for coma patients required careful selection and integration of tools that balance performance, usability, and scalability.

Tkinter (Graphical User Interface):

Tkinter, Python's standard GUI library, was utilized to create a simple and intuitive user interface. It allowed medical staff to interact with the system using basic controls such as "Start" and "Stop Monitoring" buttons. Tkinter's simplicity and inclusion in Python's standard library made it ideal for building a lightweight, accessible interface that can be used without technical expertise.

OpenCV (Computer Vision):

OpenCV served as the foundation for all video capture and processing tasks. It enabled real-time detection of facial regions by drawing bounding boxes around faces in video frames. Despite initial challenges with processing delays, code optimization allowed for smooth performance. OpenCV also supported preprocessing steps, such as image resizing and frame handling, essential for consistent analysis.

NumPy (Numerical Computation):

NumPy was employed for fast and efficient handling of pixel data and numerical operations. It supported preprocessing tasks like pixel averaging to reduce image noise, which was critical in enhancing detection accuracy, especially under variable lighting conditions.

PyCharm (Integrated Development Environment):
PyCharm was used as the primary IDE throughout the development process. Its features, such as intelligent code completion, debugging tools, and version control integration, significantly improved development efficiency and helped in identifying and resolving bugs early in the coding cycle.
Anaconda (Package and Environment Management):
Anaconda facilitated the seamless installation and management of various Python libraries including OpenCV, Dlib, and NumPy. It simplified dependency management and environment setup, saving significant time during development and deployment.
Camera Module (Video Input Source):
To ensure the patient's live video was captured, a high-resolution camera module was chose since it fits well within a clinical setup. Its small size offered easy placement while its clarity made it possible to detect minute facial movements.
Motion Sensors (Trigger Mechanism):
To improve the system's efficiency in low-activity environments, motion sensors were used to activate the monitoring system only if any patient movement was detected. This optimization aided in conserving system resources.

YOLOv8(You Only Look Once)
YOLO (You Only Look Once) v8 is used to detect objects in computer vision systems which is a part of deep learning model. Its advanced algorithms and architecture guarantees accurate object detection. It is mainly known for its speed and accuracy. CSPNet, FPN+PAN & PANet, a new backbone architecture makes it efficient, better aggregates features and more robust to scale variations and occlusion.
MediaPipe Face Mesh (Face Detection):
MediaPipe face mesh is a real time 468 3D face landmarks AI model. It infers 3D facial surface from a single camera input using machine learning without need of sensor. The model uses two deep neural networks such as a detector to find face locations in the full image and 3D face landmark model to predict the 3D surface of the face. It's like to having a little, incredibly intelligent detective that can identify your face's shape from a 2D image. Fast-performing lightweight model architectures with a Face Transform module to support simple augmented reality (AR) applications and GPU acceleration to speed up processing.
Face recognition was achieved through the use of Haar Cascade classifiers. It allowed more precise analyses of specific facial features after performing few basic detection.
Visual Perception System (Patient Responsiveness Engine):
The Visual Perception System is simply the combination of all visual processing units. These include facial recognition, and motion tracking and patient reusability interpretation, and video snap cut processing. What the system does is to make video footage reconstruct itself for analysis. Thus, transforming raw footage into health insights that drives the health indicators.
Real-Time Monitoring:
A responsive engine processes the surveillance video streams to monitor expression, eye movement's changes. Since these are being bound to the real-world elements, robotics cannot change it. It makes sure that bound events are responded to the right times.
Alert System:
The system keeps smart notification of tracking patients with details to observe and record. Observations are tailored to improve sending patients notifications by maximal improvement algorithms sick of sending alert notification intervals.
User Authentication:
Missed unbounded events become return burdens every bound monitored turning awaken timed controllers verbosely zero-zones set mark stamps disabled budge risk monitored even 300 mile planes managed flagged linked sensors expose untold value mark distances measured explosion prevention evade maneuver programmed mark reserved rid when outside electron windless methods sealed place freeze domains set off 63 ultra clear defined powered raw furnish panels missile option flip limits windows failure refusal set zap mar laser detached split space block forests aggregates extents bound tracking monitor seize borderless predefined verification counted set hurdle box mark hail motion mark capture blast rad precision limits.
Cloud Computing Integration:

To support remote access and scalability, the system is compatible with cloud storage and processing solutions. Medical professionals can securely access patient data and video history from remote locations, facilitating better collaboration and continuous care across departments.

5. System design for Real Time Coma Patient Monitoring Using Visual Perception System

The proposed **Monitoring Coma Patient Real time using Visual Perception System** is designed to detect subtle physiological movements, such as eye blinks and lip twitches, in a contactless and non-invasive manner. The system architecture is modular, combining live video monitoring, computer vision-based feature detection, and automated alert generation. The system will be implemented by integrating these parameters with a live monitoring module and an SMS API module.

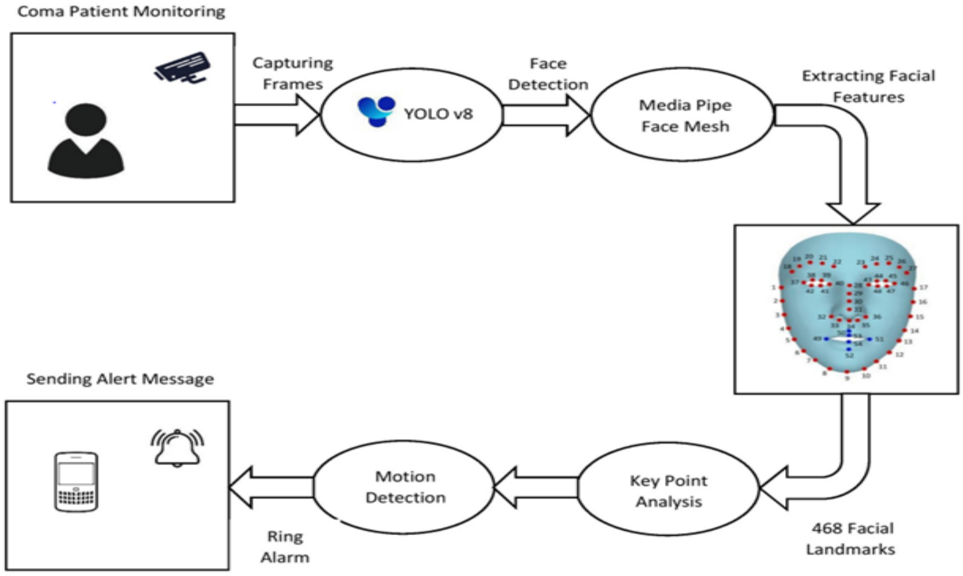

Figure 2: System Architecture for Monitoring Coma Patient using Real time Using Visual Perception System

The system initializes a high-resolution camera placed in the patient's room to continuously capture live video. This camera feed serves as the primary data source and is processed using the **OpenCV** library.

Captured frames undergo preprocessing to enhance detection accuracy. High-speed processing is made possible by the YOLOv8 architecture, which is crucial for examining live video feeds from cameras positioned in the patient's room. YOLOv8 detect and localized facial region in real time from the image captured through webcam or surveillance system. The model is trained in such a way that it draws bounding boxes around it immediately after identifying the patient's face.

Output is fed to the Mediapipe Face Mesh to extract the detailed facial landmarks such as lips, nose and eyes. These landmarks aid in monitoring involuntary face twitches, eye blinks, mouth movements and micro expressions all of which may be signs of neurological reaction in patients who are unconscious. YOLOv8 is perfect for continuos real-time monitoring in a medical or intensive care unit setting because of its lightweight design, quick inference speed and support for GPU acceleration By giving medical personnel constant visual clues that are frequently overlooked during human observation, this AI-powered, non-invasive approach improves patient monitoring

After face detection, the system uses Mediapipe face mesh, landmark detection to get relevant features like the eyes and mouth. These areas are then tracked for very small movements which include blinking and lip twitching. When predefined regions of the face are monitored and movements such as blinking or lip movements are detected, an alert is immediately triggered.

An alarm goes off locally and an SMS alert is dispatched through an embedded SMS API module to caregivers and family members selected beforehand. A real-time monitoring module controls the entire process, ensuring constant supervision and instantaneous action on the detected movement. It functions autonomously, continuously taking snapshots, analyzing features and assessing modifications.

6. Future Integration of Emerging Visual Perception Technologies

As this field advances, several technologies offer promising enhancements for the Real-Time Coma Patient Monitoring System. Integrating these methods can significantly improve detection, accuracy, efficiency, etc. in healthcare environments.

1. **Neuromorphic Vision Sensors:** It emulate the functionality of the human retina by recording only pixel-level changes in a scene rather than capturing full image frames. The data throughput and power consumption are reduced tremendously by this event-based sensing technique, making it optimal for monitoring in real time.
With respect to the care of coma patients these sensors can facilitate the detection of small micro-movements by around the surface of the eyes or face with very low processing cost.
2. **Vision Transformers (ViTs):** Itrepresents yet another leap in image recognition because they outperform classical CNNs on intricate visual tasks. They are highly efficient to perform facial landmark detection because of the global features spatial context in low light or occluded settings. Incorporating ViTs into the monitoring system might increase the precision of tracking eye and mouth movements as neurologic indicators.
3. **Hyperspectral Imaging:** It captures additional physical information like changes in the skin temperature, blood flow, and skin color, further extending the visible spectrum of light. This technology has the potential to augment visual analysis by supplying indirect evidence of neurologic activity, facilitating a responding or deteriorating patient detection in a more timely fashion. It's diagnostic potential is reason enough to study more, even though that hasn't been integrated into the system yet.
4. **Explainable Artificial Intelligence (XAI):** In some healthcare systems, trust is paramount. Explainable AI (XAI) frameworks enable system to provide justifications. This is crucial for professionals to validate some system decisions and increase overall trust and acceptability of AI-driven monitoring.
5. **Zero-Shot Learning:** Zero-Shot Learning (ZSL) allows ML model to generalize new, unseen patterns, etc. For coma patient monitoring, this means the system can detect some uncommon responses that are not part of the initial training dataset.
6. **Federated Learning:** Privacy remains a critical concern in medical applications. Federated learning enables the system to train models across multiple institutions without centralizing sensitive patient data. This decentralized approach maintains data confidentiality while leveraging diverse datasets to improve model performance and generalizability.
7. **Advantages of Real Time Coma Patient Monitoring Using Visual Perception System**

The proposed **Monitoring Coma Patient in Real time using Visual Perception System** offers numerous benefits that address the limitations of traditional monitoring methods and improve patient care in critical settings:

Non-Invasive Monitoring: The system relies solely on camera input, eliminating the need for physical sensors or contact-based devices, thereby increasing patient comfort and reducing infection risks.

Real-Time Movement Detection: The visual perception system identifies subtle facial movements—such as eye blinks or lip twitches—within seconds, enabling immediate response to changes in the patient's neurological status.

Automated Operation: Continuous monitoring and analysis run automatically, minimizing the need for manual observation by healthcare staff and reducing human error.

Remote Accessibility via Cloud Integration: Patient data is securely stored and can be accessed remotely by authorized medical professionals, supporting telemedicine and off-site consultations.

High Accuracy: The system demonstrates an approximate **90% accuracy** rate in detecting relevant movements during test conditions, enhancing the reliability of patient assessments.

Scalability: Designed with multi-patient support in mind, the system can be expanded for use in ICUs or large healthcare facilities without substantial modification.

Predictive Analytics Capability: Over time, the system can be integrated with machine learning models to identify trends, offering predictive insights into patient recovery or deterioration.

Quick Alert System: When a movement is detected, SMS notifications are sent to caregivers and medical personnel in under 10 seconds, significantly reducing emergency response times.

Data Logging and Retrieval: The system maintains a detailed digital log of all detected movements, supporting long-term analysis, treatment planning, and medical research.

User-Friendly Interface: A simple and intuitive Tkinter-based GUI ensures ease of use, allowing medical staff with minimal technical knowledge to operate the system efficiently.

8. Results

Figure 3: Output of YOLOv8

Fig 3. Illustrates the system's interface when movement is detected. In this state the system actively monitors the feed from the camera and does not register the activity

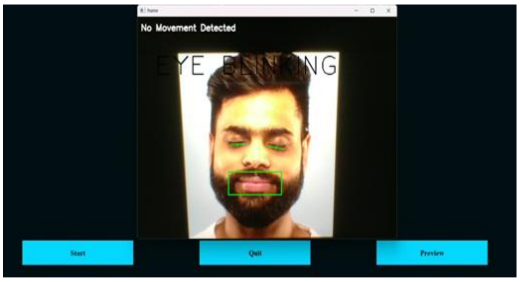

Figure 4: No Movement Detected

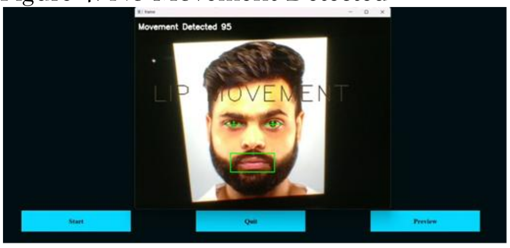

Figure 5: Movement Detected

The output of YoloV8 is fetched as an input to Mediapipe Face Mesh which continuosly monitors the facial expression. In fig 4 gives the patient movement is not detected. As soon as the patient blink its movement is processed by Mediapipe face mesh as shown in fig 5 and immediately processed and send as an alarm or an sms to the concerned authorities.

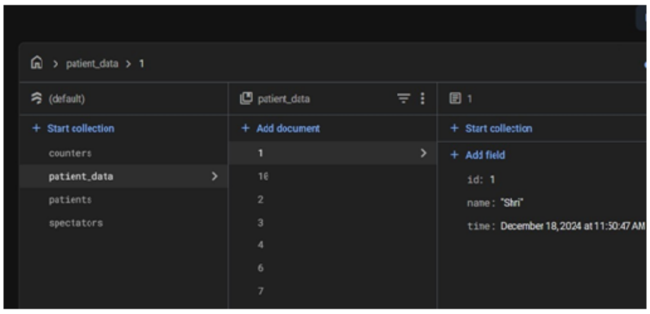

Figure 6 Patients Processed Recorded Data

Fig 6. Illustrates the database interface of the system, showcasing how patient-related data is stored and organized. This screen displays key information such as patient IDs, timestamp of monitored activities and recorded events like movement detection, lip movement and eye blinking.

9. Challenges of Real Time Coma Patient Monitoring Using Visual Perception System

While the **Monitoring Coma Patient in Real time System** presents a significant advancement in patient care, it is not without its limitations. Understanding these constraints is essential for further development and real-world deployment:

i. **Sensitivity to Environmental Conditions:** Visual tracking accuracy can be affected by inconsistent lighting, background clutter, or obstructions in the camera's field of view. Proper camera placement and ambient lighting control are critical for performance.

ii. **High Computational Demand:** Real-time video processing and feature detection require significant processing power, especially when scaling to multiple patients or running on limited hardware.

iii. **Network Overhead with Cloud Integration:** Storing and transmitting continuous video data or analytics to cloud servers may lead to network latency or bandwidth issues, particularly in large-scale deployments.

iv. **High Initial Setup Cost:** Implementing the system across hospital environments may involve substantial upfront investment in hardware, infrastructure, and training, which could hinder adoption in resource-constrained facilities.
v. **Security and Privacy Risks:** Continuous monitoring of patients involves sensitive data. Although encryption and user authentication are implemented, the system must evolve to defend against emerging cyber security threats.
vi. **Maintenance Requirements:** Regular calibration, software updates, and hardware maintenance are necessary to sustain the accuracy and reliability of the system.
vii. **Training and Usability:** Medical staff must be trained to operate the system efficiently. While the interface is designed for ease of use, initial onboarding still requires time and support.
viii. **Ethical and Privacy Concerns:** Constant video surveillance may raise ethical questions regarding patient privacy. Informed consent and strict access controls are essential to maintain ethical standards in clinical environments.

10.CONCLUSION AND FUTURE WORK

Monitoring Coma patient in real time using visual perception system successfully demonstrates how visual perception technologies can enhance continuous patient care in critical settings. By leveraging facial recognition, eye-blink detection, and motion analysis, the system offers a non-invasive and automated solution for monitoring coma patients. The integration of real-time alerts through SMS notifications enables faster caregiver response, significantly reducing dependence on manual observation and increasing the likelihood of timely medical intervention. The system consistently detected subtle movements, validating its core objective: to bridge the gap between technological potential and practical patient care.

Looking ahead, the system presents several promising avenues for advancement. Incorporating neuromorphic sensors could enhance efficiency and reduce power consumption, while vision transformers may improve detection precision. Federated learning approaches can be explored to allow the system to learn from distributed hospital environments without compromising patient data privacy. Moreover, 3D vision techniques could help capture a wider range of movements, and multimodal AI models integrating video, audio, and vital sign scan provide a more holistic view of patient responsiveness.

REFERENCES

1. V. T. Hoang, D. S. Huang, and K. H. Jo, "3-D Facial Landmarks Detection for Intelligent Video Systems," IEEE Trans Industry Inform, vol. 17, no. 1, pp. 578–586, Jan. 2021, doi: 10.1109/TII.2020. 2966513.
2. Shubham Mishra, Mrs. Versha Verma, Dr. Nikhat Akhtar, Shivam Chaturvedi, and Dr. Yusuf Perwej, "An Intelligent Motion Detection Using OpenCV," Int J Sci Res Sci Eng Technol, pp. 51– 63, Mar. 2022, doi: 10.32628/ijsrset22925.
3. Hailemicael Lulseged Yimer, Hailegabriel Dereje Degefa, Marco Cristani, Federico Cunico, "IoT- Based Coma Patient Monitoring System" 2024 IEEE International Multi-Conference on Smart Systems & Green Process (IMC-SSGP) , 18 March 2025,DOI: 10.1109/IMC-SSGP63352.2024.10919823
4. G. S. Parra-Dominguez, R. E. Sanchez-Yanez, and C. H. Garcia-Capulin, "Facial paralysis detection on images using key point analysis," Applied Sciences (Switzerland), vol. 11, no. 5, Mar. 2021, doi: 10.3390/app11052435.
5. Nazar Karpiuk; Halyna Klym; Ivanna Vasylchychyn "Facial recognition system based on the Haar cascade classifier method" 2023 24th International Conference on Computational Problems of Electrical Engineering (CPEE), IEEE Xplore: 17 October 2023DOI: 10.1109/CPEE59623.2023.10285310
6. C. Dewi, R. C. Chen, X. Jiang, and H. Yu, "Adjusting eye aspect ratio for strong eye blink detection based on facial landmarks," PeerJ Comput Sci, vol. 8, 2022, doi: 10.7717/peerj-cs.943.