FORM 2

THE PATENTS ACT, 1970

(39 of 1970)

&

THE PATENTS RULES, 2003

PROVISIONAL/COMPLETE SPECIFICATION

(See section 10 and rule 13)

1. TITLE OF THE INVENTION

COMPUTER VISION BASED REAL TIME PATIENT SURVEILLANCE AND BEHAVIOURAL MONITORING SYSTEM

2. APPLICANT(S)

NAME	AMITY UNIVERSITY, JHARKHAND
NATIONALITY	INDIAN
ADDRESS	City Campus, Nivaranpur, Main Road, Ranchi JHARKHAND, INDIA – 834001

3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is to be performed.

Signature Not Verified
Digitally Signed.
Name: Praveen Kumar Maduri
Date: 25-Sep-2023 13:11:31
Reason: Patent Efiling
Location: DELHI

TITLE

COMPUTER VISION BASED REAL TIME PATIENT SURVEILLANCE AND BEHAVIOURAL MONITORING SYSTEM

FIELD OF INVENTION

[001] The invention relates to the field of healthcare technology systems aimed at monitoring and enhancing patient well-being within healthcare facilities. More specifically, the invention combines computer vision, hardware sensors, software, and machine learning to create a sophisticated patient surveillance and behavioral monitoring system, revolutionizing the way healthcare professionals provide care and ensuring patients' physical and emotional needs are met in real-time.

PRIOR ART

[002] The Chinese Patent Application numbered CN204192591 titled “SELF-NETWORKING REAL-TIME CLINIC PATIENT SIGN MONITORING SYSTEM” describes a self-networking real-time clinic patient sign monitoring system. This system consists of a patient bed tracking monitoring terminal, a remote monitoring unit, and a computer, all interconnected. The patient bed tracking monitoring terminal is equipped with a system-on-chip, a temperature sensor, an LED display module, and an intelligent power system, all interconnected. Within the system-on-chip, a microprocessor and a radio frequency transceiver module are integrated. The LED display module includes both an LED drive chip and an LED screen, while the intelligent power system comprises a power management chip and a single lithium battery. This compact system allows for real-time monitoring of multiple patient signs, continuous recording of monitoring data, and immediate alarms in case of abnormal data. It is designed with portability in mind, making it easy to carry and deploy in clinical settings.

[003] The Korean Patent Application numbered KR1020140126933 titled “SMART PATIENT MONITORING SYSTEM” pertains to an intelligent patient monitoring system designed for tracking a patient's historical and current health status. This system achieves this by allowing remote access to a patient management server through the patient's personal smart device, regardless of the presence of caregivers. In real-time, the patient's current condition is recorded in a database and can be monitored remotely via the smart device, providing a comprehensive view of the patient's health history and present state. Additionally, in the event of an emergency, the system has the capability to automatically alert the user through their smart device, enabling rapid response and intervention. This invention greatly enhances the management and care of patients, ensuring that their health status is closely monitored, and that timely action can be taken, when necessary, even when caregivers are not physically present.

[004] The Chinese Patent Application numbered CN110179442 titled “REAL-TIME MONITORING SYSTEM FOR PATIENT” introduces a real-time monitoring method for hospital patients, which involves gathering essential patient information, generating a two-dimensional code, and transmitting it to an electronic wristlet. The method retrieves department-specific information and associates it with the code. It also periodically compares the patient's body temperature data to a preset range, sending control instructions if the temperature difference falls outside this range. This method enhances patient monitoring and improves medical personnel's effectiveness in providing care.

[005] The Indian Patent Application titled numbered IN202011042762 titled “REAL-TIME PATIENT MONITORING SYSTEM AT ICU USING ESP 32 MODULE” features an IoT-based patient monitoring system utilizing the ESP32 module. This system actively gathers real-time sensory data from patients using temperature and pulse rate sensors. In conjunction, a camera integrated with the system captures visual data in real-time. The ESP32 module compiles patient information and promptly transmits this real-time data to a cloud server via the internet. This cloud-based data repository is easily accessible to attending doctors and nurses, who can securely view it remotely through a mobile application or web application utilizing wireless communication. It's noteworthy that the ESP32 is a versatile module with dual capabilities, combining Wi-Fi and Bluetooth Low Energy (BLE), enabling seamless communication either over the internet or through Bluetooth connections. This integration enhances the overall monitoring efficiency and accessibility of patient data for healthcare professionals.

SUMMARY

[006] The following presents a simplified summary of the invention to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the present invention. It is not intended to identify the key/critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some concept of the invention in a simplified form as a prelude to a more detailed description of the invention presented later.

[007] The present invention incorporates strategically placed high-resolution cameras equipped with wide-angle lenses and night vision capabilities. These cameras capture visual data that offers real-time, precise monitoring of patients. In collaboration with these cameras, the system employs a powerful processing unit

composed of a multi-core CPU and dedicated GPUs to run the healthcare monitoring software and manage the machine learning models required for real-time data interpretation.

[008] An assortment of sensors enriches the data gathered. These include temperature sensors to monitor body temperature precisely, high-quality microphones to record audio data for cough and sneeze detection, and accelerometers to ensure accurate fall detection. The network infrastructure of the system uses both Ethernet and Wi-Fi to ensure smooth and fast data transmission to a central server or cloud-based storage.

[009] To ensure uninterrupted operation during power outages, the system incorporates Uninterruptible Power Supply (UPS) units. Moreover, integrated LED lighting provides optimal illumination. Flexible and adjustably mounted cameras provide augmented monitoring regardless of the ambient lighting conditions.

[010] From the software perspective, the system employs a Linux-based operating system for stability and reliability. Computer Vision and Machine Learning frameworks like OpenCV, TensorFlow, and Dlib power tasks such as facial expression analysis and posture recognition. Data exchange between IoT devices is conducted using the lightweight messaging protocol MQTT. Video streaming, recording, and conversion leverage tools like FFmpeg and GStreamer, allowing real-time capture and data transmission.

[011] The system ensures secure and scalable data storage, using a combination of relational and NoSQL databases, complemented by cloud-based storage solutions. In addition, the distributed data processing framework Apache Spark is used for data analytics tasks. Libraries like Pandas and NumPy are deployed for data analysis and manipulation. For tasks that require fast decisions and responses, the system integrates real-time operating systems or frameworks.

[012] The security of data exchange and communications is safeguarded by the implementation of secure communication protocols, and the user interface employs web development frameworks like React, Angular, and data visualization libraries like D3.js and Matplotlib. These components add to the usability and understanding of the system.

[013] On the machine learning front, the system uses an array of algorithms designed for specific monitoring tasks. CNNs help analyze camera images to track a patient's body positions for posture and mobility tracking. Facial landmark detection models aid in the identification of key facial features for emotional status monitoring. SVM and Decision Tree-based algorithms work with accelerometer data to detect falls or unusual movement. Audio analysis, able to classify coughs and sneezes, employs machine learning models like RNNs and CNNs, while CNNs also track hand movements that facilitate insights on rehabilitation progress.

[014] Object detection models recognize food containers, ensuring adherence to feeding habits. Deep learning models classify medication containers or pills, helping monitor medication intake. Sleep monitoring uses RNNs and LSTM models to analyze accelerometer data. Additionally, object detection models assist in recognizing healthcare uniforms or badges, ensuring patients are attended by healthcare professionals.

OBJECTIVE(S)

[015] The primary objective of the invention is to improve the quality of patient care by continuously monitoring patients' physical and emotional well-being in real-time. The system aims to detect early signs of health issues, ensuring timely interventions and improved patient outcomes.

[016] Yet another objective is to focus on behavioral analysis, including monitoring facial expressions, hand movements, and sleep patterns. The objective is to gain insights into patients' emotional states and physical activities, which can aid in providing tailored care and support.

[017] Yet another objective is to check that patients take medications as prescribed is crucial for their well-being. The system's medication adherence monitoring objective is to track and remind patients to take their medications on time, promoting treatment compliance.

[018] Yet another objective is to optimize healthcare workflows by providing real-time information about patient conditions and the presence of healthcare professionals. This helps in resource allocation and ensures that patients receive timely care.

[019] Yet another objective is to ensure fall detection and continuous monitoring contribute to patient safety within healthcare facilities. The objective is to reduce the risk of accidents and injuries among patients, especially those with mobility issues.

[020] Yet another objective is to improve healthcare monitoring by automating various monitoring tasks through computer vision and machine learning, the system aims to free up healthcare professionals' time for more critical patient care tasks, leading to improved efficiency in healthcare settings.

[021] Yet another objective is to ensure the collection and analysis of patient data generate valuable insights into healthcare trends and individual patient conditions. The objective is to leverage this data to enhance decision-making and optimize healthcare practices.

[022] Yet another objective is to ensure the privacy and security of patient data is a fundamental objective. The system aims to comply with healthcare data regulations (e.g., HIPAA, GDPR) and implement robust security measures to protect sensitive information.

DESCRIPTION OF DRAWING(S)

[023] Reference will be made to embodiments of the invention, example of which may be illustrated in the accompanying figure(s). These Figure(s) are intended to be illustrative, not limiting. Although the invention is generally described in the context of these embodiments, it should be understood that it is not intended to limit the scope of the invention to these particular embodiments only:

[024] FIG. 1 – Illustration of the Architecture

DETAILED DESCRIPTION

[025] CALL OUT LIST

[026] 101 – Processing Unit

[027] 102 – Cameras

[028] 103 – Lighting

[029] 104 – Network Infrastructure

[030] 105 – Power Supply

[031] 106 – Mounting and Positioning Hardware

[032] 107 – Sensors

[033] 108 – Microphones

[034] 109 – Display Unit

[035] 201 – Operating System

[036] 202 – Computer Vision & Machine Learning Frameworks

[037] 203 – IoT Integration

[038] 204 – Data Storage and Databases

[039] 205 – Data Processing and Analytics

[040] 206 – Real-Time Processing and Control

[041] 207 – Communication and Networking

[042] 208 – User Interface and Visualization

[043] 209 – Data Security and Privacy

[044] 301 – Convolutional Neural Networks (CNNs)

[045] 302 – Support Vector Machines (SVMs)

[046] 303 – Recurrent Neural Networks (RNNs)

[047] 304 – Long Short-Term Memory (LSTM)

[048] The exemplary embodiments described herein detail for illustrative purposes are subject to many variations in the structure and design. It should be emphasized, however, that the present invention is not limited to a particular device as shown and described herein. It is understood that various omissions and substitutions of equivalents are contemplated as circumstances may suggest or render expedient, but these are intended to cover the application or implementation without departing from the scope of the claims of the present invention. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

[049] The use of terms “including,” “comprising,” “having”, “containing," or "involving” and variations thereof herein are meant to encompass the items listed thereafter and equivalents thereof as well as additional items.

[050] Further, the terms, “an” and “a” herein do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced items.

[051] The foregoing description of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The exemplary embodiment was chosen and described in order to best explain the principles of the invention and its practical application, to thereby enable others skilled in the art to best utilize the invention. It is understood that various omissions, and substitutions of equivalents are contemplated as circumstance may suggest or render expedient but is intended to cover the application or implementation without departing from the scope of the claims of the present invention.

[052] The "Computer Vision-Based Real-Time Patient Surveillance and Behavioural Monitoring System" represents a revolutionary invention that redefines patient care and monitoring within healthcare settings. By providing real-time insights into patients' physical and emotional well-being, this system enhances patient outcomes, facilitates early detection of health issues, and optimizes the workflow of healthcare professionals, ushering in a new era of healthcare delivery marked by improved quality and efficiency.

[053] The "Computer Vision-Based Real-Time Patient Surveillance and Behavioural Monitoring System" is an innovative healthcare monitoring system meticulously designed to provide real-time monitoring of patients' physical and emotional well-being within healthcare settings. This comprehensive system integrates advanced hardware, sophisticated software, and cutting-edge machine learning algorithms, offering numerous benefits for patient care, early health issue detection, and healthcare professional workflow optimization.

[054] The system has a processing unit equipped with a multi-core CPU and dedicated GPUs, ensuring robust data processing and analysis. This processing unit efficiently runs the healthcare monitoring software and hosts the machine learning models, all while maintaining a high level of performance and responsiveness.

[055] The visual data is captured by high-resolution cameras strategically placed in patient rooms and common areas. These cameras feature wide-angle lenses and night vision capabilities, ensuring clear and comprehensive monitoring regardless of lighting conditions. Accompanying the visual data, various sensors contribute to the system's functionality. Temperature sensors provide precise body temperature monitoring, while high-quality microphones capture audio data, crucial for cough and sneeze detection. Accelerometers ensure accurate fall detection, contributing to patient safety.

[056] To facilitate seamless data transmission, the system is connected to a secure, high-speed network infrastructure that supports both Ethernet and Wi-Fi connectivity. This network setup ensures that data is efficiently and promptly transmitted to central servers or cloud-based storage, allowing for real-time monitoring and analysis. Furthermore, Uninterruptible Power Supply (UPS) units are integrated to guarantee continuous monitoring, even during power outages.

[057] The system is thoughtfully equipped with LED lighting to ensure optimal camera performance. These lighting fixtures provide consistent illumination, further enhancing the quality of monitoring data. Sturdy and adjustable mounts and brackets secure the cameras in place, offering flexibility in placement and alignment to accommodate various monitoring scenarios. For real-time visualization and control, optional high-resolution monitors are available, displaying essential data to healthcare professionals. User-friendly interface components enhance the overall user experience, enabling easy system configuration and control.

[058] On the software front, the system runs on a stable and reliable Linux-based operating system, providing a solid foundation for the entire healthcare monitoring infrastructure. The software stack includes industry-leading computer vision and machine learning frameworks such as OpenCV, TensorFlow, and Dlib. These frameworks empower the system's computer vision capabilities, enabling tasks like facial expression analysis and posture recognition with high accuracy and performance.

[059] Efficient sensor data exchange is facilitated through MQTT (Message Queuing Telemetry Transport), a lightweight IoT messaging protocol known for minimal latency and efficient communication. Video streaming and capture are managed by powerful tools such as FFmpeg and GStreamer, ensuring the real-time capture and transmission of vital visual data.

[060] Patient data is securely stored in a combination of relational and NoSQL databases, with cloud-based storage solutions ensuring scalability and data redundancy. Data analytics tasks are efficiently handled by Apache Spark, a distributed data processing framework, and libraries like Pandas and NumPy are leveraged for data manipulation and analysis. To maintain low-latency and deterministic behaviour for critical tasks, real-time operating systems (RTOS) or frameworks are seamlessly integrated.

[061] Secure communication protocols, including RESTful APIs and HTTPS, safeguard data exchange and communication, ensuring data security and privacy compliance in healthcare settings. The system's intuitive user interface is built using web development frameworks such as React and Angular, offering an engaging user experience. Data visualization libraries like D3.js and Matplotlib enhance the presentation of monitoring data, ensuring healthcare professionals have a clear understanding of patient status.

[062] The healthcare monitoring system employs a diverse array of machine learning algorithms tailored to specific monitoring tasks. Convolutional Neural Networks (CNNs) analyze camera images for posture recognition, while facial landmark detection models enable facial expression analysis. Support Vector Machines (SVMs) and Decision Trees process accelerometer data for fall detection, and audio analysis relies on models like Recurrent Neural Networks

(RNNs) and Convolutional Neural Networks (CNNs) for cough and sneeze detection.

[063] Object detection models, such as YOLO and Faster R-CNN, accurately identify objects like food containers for eating and drinking monitoring. Deep learning models classify medication containers or pills based on camera images, and time series analysis techniques like Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks monitor continuous vital signs.

[064] The system uses object detection models to identify and recognize healthcare professionals' uniforms or badges, ensuring that patients receive timely care and attention from the medical staff.

[065] HARDWARE COMPONENTS: At the core of the Computer Vision-Based Real-Time Patient Surveillance System are hardware components that ensure robust and accurate monitoring:

High-resolution cameras, equipped with wide-angle lenses and night vision capabilities, are strategically positioned in patient rooms and common areas. These cameras capture visual data, offering clear and comprehensive monitoring.

The system relies on a powerful computer with a multi-core CPU and dedicated GPUs. This processing unit efficiently runs the healthcare monitoring software and hosts the machine learning models required for real-time data analysis.

Complementing the camera data, various sensors have been incorporated into the system. Temperature sensors enable precise body temperature monitoring, while high-quality microphones capture audio data for cough and sneeze detection. Additionally, accelerometers ensure accurate fall detection.

The system is seamlessly connected to a secure, high-speed network, featuring both Ethernet and Wi-Fi connectivity options. This ensures the smooth and timely transmission of data to a central server or cloud-based storage.

To guarantee uninterrupted monitoring, the system is equipped with Uninterruptible Power Supply (UPS) units, ensuring continuous operation even during power outages.

LED lighting has been thoughtfully integrated to provide optimal illumination for camera performance, ensuring consistent monitoring quality, regardless of ambient lighting conditions.

Sturdy, adjustable mounts, and brackets secure the cameras in place, offering flexibility in placement and alignment for different monitoring scenarios.

Real-time monitoring is facilitated through high-resolution monitors that display essential data. User-friendly interface components allow for easy system configuration and control, enhancing the overall user experience.

[066] SOFTWARE AND TECHNOLOGY STACK: The healthcare monitoring system leverages a meticulously curated software and technology stack to enable seamless data processing, analysis, and visualization:

The system operates on a stable and reliable Linux-based operating system, providing a solid foundation for the entire healthcare monitoring infrastructure.

Industry-leading frameworks like OpenCV, TensorFlow, and Dlib power the system's computer vision capabilities. These frameworks enable tasks such as facial expression analysis and posture recognition, ensuring high accuracy and performance.

Efficient sensor data exchange is enabled through MQTT (Message Queuing Telemetry Transport), a lightweight IoT messaging protocol known for minimal latency and efficient communication.

FFmpeg and GStreamer serve as powerful tools for video streaming, recording, and conversion. These technologies facilitate the real-time capture and transmission of vital visual data.

Patient data is securely stored in a combination of relational and NoSQL databases, with cloud-based storage solutions ensuring scalability and data redundancy, guaranteeing the integrity of patient records.

Apache Spark, a distributed data processing framework, efficiently handles data analytics tasks. Libraries such as Pandas and NumPy are leveraged for data manipulation and analysis, ensuring that healthcare professionals have access to meaningful insights.

Real-time operating systems (RTOS) or frameworks are seamlessly integrated to guarantee low-latency, deterministic behavior. These systems are essential for critical tasks that require rapid decision-making and response.

Secure communication protocols, including RESTful APIs and HTTPS, safeguard data exchange and communication, ensuring data security and privacy compliance in healthcare settings.

The system's intuitive user interface, built using web development frameworks such as React and Angular, offers an engaging user experience. Data visualization libraries like D3.js and Matplotlib enhance the presentation of monitoring data, ensuring healthcare professionals have a clear understanding of patient status.

[067] MACHINE LEARNING ALGORITHMS:

The healthcare monitoring system deploys a diverse array of machine learning algorithms, meticulously tailored to specific monitoring tasks:

Convolutional Neural Networks (CNNs) are employed for image-based posture recognition. These models analyze camera images, accurately identifying and tracking patients' body positions.

Facial landmark detection models, such as Dlib, enable the detection of key facial features. Machine learning algorithms then analyze the positions of these landmarks to infer patients' facial expressions, providing insights into their emotional states.

Algorithms based on Support Vector Machines (SVMs) and Decision Trees process accelerometer data to detect sudden falls or unusual movements, ensuring timely intervention.

Audio analysis relies on machine learning models, including Recurrent Neural Networks (RNNs) and Convolutional Neural Networks (CNNs), to classify coughs and sneezes accurately, contributing to early symptom detection.

Convolutional Neural Networks (CNNs) are employed to detect and classify hand movements, providing valuable insights into patients' physical rehabilitation progress.

Object detection models, such as YOLO (You Only Look Once) and Faster R-CNN, accurately identify and recognize objects like food containers, ensuring that patients are properly nourished.

Deep learning models are trained to classify medication containers or pills based on camera images, helping to monitor patients' medication adherence.

Accelerometer data is analysed using machine learning techniques like Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks. These models classify sleep patterns, including wakefulness, light sleep, and deep sleep, enabling comprehensive sleep monitoring.

Object detection models identify and recognize healthcare professionals' uniforms or badges, ensuring that patients receive timely care and attention from the medical staff.

[068] The foregoing descriptions of exemplary embodiments of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The exemplary embodiment was chosen and described in order to best explain the principles of the invention and its practical application, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated. It is understood that various omissions, substitutions of equivalents are contemplated as circumstance may suggest or render expedient but is intended to cover the application or implementation without departing from the scope of the claims of the present invention.

CLAIMS

I/We Claim

1. A Computer Vision-Based Real-Time Patient Surveillance and Behavioural Monitoring System, comprising:
    a. A processing unit (101) with a multi-core CPU and dedicated GPUs;
    b. A plurality of high-resolution cameras (102) equipped with wide-angle lenses and night vision capabilities;
    c. An LED lighting (103) fixture;
    d. A network infrastructure (104) with Ethernet or Wi-Fi connectivity options, ensuring seamless data transmission to a central server or cloud-based storage;
    e. An Uninterruptible Power Supply (UPS) unit (105);
    f. Sturdy mounts and brackets (106);
    g. A plurality of microphones (108) for audio analysis (cough and sneeze detection);
    h. A display unit (109) for real-time data visualization;
    i. A software stack; and
    j. A set of machine learning algorithms.

2. The system as claimed in Claim 1, wherein the software stack comprises:
    a. A Linux-based operating system (201) for system stability and reliability.
    b. Computer vision and machine learning frameworks (202), including OpenCV, TensorFlow, and Dlib, for facial expression analysis, posture recognition, and other computer vision tasks.
    c. IoT integration (203) through MQTT for lightweight IoT messaging and sensor data exchange.
    d. Video streaming and capture using FFmpeg and GStreamer for real-time data capture.
    e. Data storage and databases (204) for secure patient data storage, including relational and NoSQL databases, with cloud-based storage for scalability and redundancy.
    f. Data processing and analytics (205) facilitated by Apache Spark, data analysis libraries like Pandas and NumPy, and real-time processing and control (206) through real-time operating systems or frameworks for low-latency and deterministic behaviour.

g. Communication and networking (207) employing RESTful APIs and secure communication protocols for data exchange and security.

h. User interface and visualization (208) developed using web development frameworks and data visualization libraries to present monitoring data to healthcare professionals and caregivers.

i. Data security and privacy (209) ensured through robust encryption protocols, access control mechanisms, and compliance with healthcare data privacy regulations.

3. The system as claimed in Claim 1, wherein the set of machine learning algorithms comprise:

a. Convolutional Neural Networks (CNNs) (301) for image-based posture recognition and facial expression analysis.

b. Support Vector Machines (SVMs) (302) and Decision Trees for accelerometer-based fall detection.

c. Recurrent Neural Networks (RNNs) (303) or Convolutional Neural Networks (CNNs) for audio-based cough and sneeze detection.

d. Object detection models like YOLO or Faster R-CNN for identifying objects in the patient's environment.

e. Time series analysis techniques, including Recurrent Neural Networks (RNNs) (303) and Long Short-Term Memory (LSTM) networks (304), for continuous vital sign monitoring.

For AMITY UNIVERSITY, JHARKHAND

Authorized Signatory

Dr. Praveen Kumar Maduri (Director IQAC)

ABSTRACT

The COMPUTER VISION-BASED REAL-TIME PATIENT SURVEILLANCE AND BEHAVIORAL MONITORING SYSTEM is a healthcare monitoring solution that uses advanced hardware, software, and machine learning technologies to improve patient care. The system uses high-resolution cameras, a powerful processing unit, temperature sensors, microphones, and accelerometers to capture visual data. The network infrastructure ensures efficient data transmission, while Uninterruptible Power Supply units ensure uninterrupted monitoring. The software stack is robust, featuring a Linux-based operating system, computer vision and machine learning frameworks, IoT integration, and video streaming and capture using FFmpeg and GStreamer. Patient data is securely stored in relational and NoSQL databases, and data analytics are performed using Apache Spark and libraries like Pandas. Machine learning algorithms cover various tasks, such as posture recognition, facial expression analysis, fall detection, and medication adherence monitoring.

FIG. 1

For AMITY UNIVERSITY, JHARKHAND

Authorized Signatory
Dr. Praveen Kumar Maduri (Director IQAC)