FORM 2

THE PATENTS ACT, 1970 (39 of 1970)

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THE PATENTS RULES, 2003

COMPLETE SPECIFICATION

**1. TITLE OF THE INVENTION**

Using existing CCTV network for crowd management, crime prevention, and work monitoring using AI/ML

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| --- | --- | --- | --- |
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**Title**Using existing CCTV network for crowd management, crime prevention, and work monitoring using AI/ML

**Field of the Invention  
[0001]** The present invention pertains for integrating Artificial Intelligence (AI) into railway systems enhances operational efficiency, crowd management, safety, and service quality through intelligent automation and real-time analytics.

**Background**

**[0002]** Traditional railway systems struggle to manage growing passenger volumes, maintain safety, and sustain operational efficiency. Reliance on manual processes and outdated technologies results in delays, inefficiencies, and safety vulnerabilities. Advancements in Artificial Intelligence (AI) offer transformative solutions through predictive analytics, intelligent monitoring, and automation, addressing these challenges effectively and enhancing railway operations.

**[0003]** In recent years, most studies analysed concentrate on the rail area, particularly where trains operate, due to the critical safety implications of rail surface anomalies and fastening system issues that can lead to severe accidents. The majority of datasets used in the studies are images rather than videos or signals, with a significant focus on detection tasks. The review highlights a lack of attention to the adaptability of models across different datasets.

**[0004]** The-current monitoring practices of railway systems: such monitoring more frequently relies on straightforward thresholding techniques to detect faults within railway systems. Though these are the most widely used techniques, they produce a large number of false alarms and often fail to detect a real failure. The continuous work done in research for development of monitoring techniques. It comprises its ability to bind more advanced algorithms capable of doing complex data analytics with fewer false positives

**[0005]** For crowd detection, researchers have devised a technique that can bypass the crowd density estimation defects. That was achieved by dividing its image into overlapping patches. This gives crowds more uniformity in smaller areas, so the accuracy of the local crowd counts is higher.

**[0006]** The platform is designed to generate alarms upon detecting anomalies, accompanied by a short video clip to validate the incident. This ensures swift identification and resolution of false alarms, enhancing reliability. Additionally, the system integrates auxiliary services, enabling users to troubleshoot issues efficiently with a single click, minimizing response time through advanced technological solutions.

**Objects of the Invention**

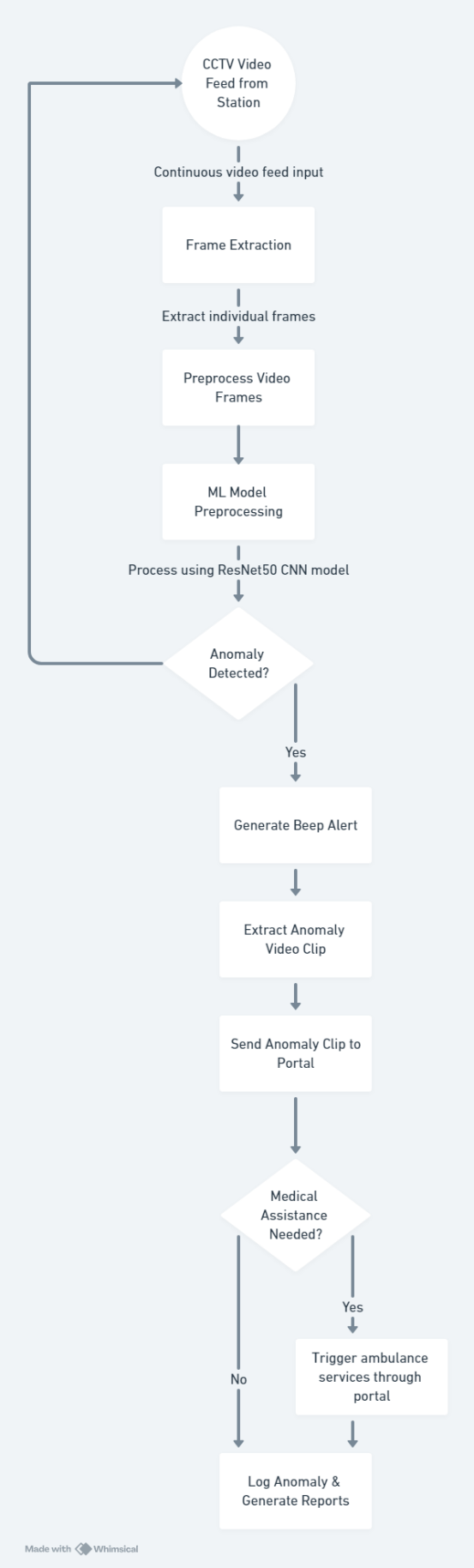
**[0007]** The project aims to develop an AI-powered system that utilizes machine learning models to analyse live video feeds and sensor data from railway stations. This system will estimate crowd density, predict congestion, and generate real-time alerts to prevent overcrowding. It will guide passengers through dynamic notifications and signage to manage flow and ensure smooth boarding and alighting during peak hours.

**[0008]** Implementing advanced computer vision techniques to analyse behavioural patterns and detect anomalies, developing AI models to estimate crowd density and detect overcrowded zones using live CCTV feed. Analysing passenger movement patterns to predict congestion points during peak hours. Enabling dynamic resource allocation, such as deploying additional staff or opening more gates, ensuring smooth passenger flow and minimizing disruptions.

**[0009]** The platform will automate the supervision of staff activities, such as cleaning, maintenance, and adherence to safety protocols. Providing real-time insights into task completion rates, performance metrics, and compliance with operational standards. Ensuring efficient station management through data-driven monitoring, reducing manual oversight.

**[0010]** The platform will integrate OpenCV for frame extraction, preprocessing, and object detection, enabling efficient video analysis. Utilizing optimized ML models to ensure real-time anomaly detection without delays, making the system responsive to dynamic railway operations. Generating detailed reports with video clips and key metrics for security reviews, operational improvements, and compliance monitoring. Providing a centralized portal for easy access to incident data and decision-making.

**Figures/Models**



**Brief Description**

**[0011]** Figure 1 The proposed system integrates AI into railway operations using advanced machine learning models, IoT devices, and computer vision techniques. Key features include real-time crowd density mapping, intelligent video analytics for safety monitoring, and predictive algorithms for optimizing resource allocation. AI-driven dashboards will provide actionable insights to railway authorities for better decision-making, ensuring efficiency, safety, and passenger satisfaction.

### **Detailed Description:**

**[0012]** Figure 1 AI algorithms will process live data from surveillance cameras and IoT sensors to estimate crowd density and predict congestion points. Automated alerts and real-time guidance systems will ensure smooth passenger movement during peak hours or emergencies.

**[0013]** AI-powered surveillance systems will analyse live video feeds to detect suspicious behaviour, unattended luggage, or potential threats. Alerts will be sent to authorities for immediate action, enhancing overall security.

**[0014]** AI models trained on historical maintenance data predict equipment failures by analysing factors like usage patterns, wear and tear, and environmental conditions. By leveraging IoT sensors and machine learning algorithms, these models forecast potential issues, enabling proactive scheduling of repairs at optimal times. This predictive approach minimizes disruptions, reduces downtime, improves safety, and enhances operational efficiency, ensuring timely interventions before failures occur. Consequently, it saves costs on emergency repairs, extends asset longevity, and promotes smoother, safer railway operations.

**[0015]** During the development phase, appropriate technologies and programming languages are utilised to create the system in accordance with the predefined design. Key features like crime detection, crowd management and work monitoring can be enhanced by leveraging the use of machine learning technologies.

**[0016]** After development, the system undergoes thorough testing to identify and fix any bugs, errors, or inconsistencies. This includes unit testing, integration testing, and system testing to validate the functionality of individual components and their overall performance. Feedback is solicited from stakeholders to further refine the system and ensure a reliable user experience.

**[0017]** Once testing is complete, the railway management system is deployed on a secure server or cloud platform, making it accessible to authorised users within the railway department. Permissions and access controls are configured to maintain data privacy and security.

### **Claims**

We Claim:

1. A system that uses ML and DL (CNN) to analyse live video feeds, detect overcrowding, and manage passenger flow with real-time alerts and guidance, ensuring safety and efficiency.
2. An intelligent surveillance solution leveraging computer vision and behavioural analysis to identify suspicious activities, capture video evidence, and notify security teams for immediate action.
3. A system that uses ML to analyse historical and sensor data to predict equipment failures, enabling timely repairs, minimizing downtime, and ensuring operational safety.
4. A vision-based system that identifies objects on railway tracks or hazardous conditions in real time, triggering alerts and activating automated countermeasures to prevent accidents.
5. An AI-driven data management system that anonymizes video and passenger data while ensuring compliance with privacy laws and secure data handling during processing and storage.

### **Technologies Used**

1. **Frontend**

The frontend will be built using **React** or **Angular** to create a responsive and user-friendly interface for security personnel and administrators. It will include features like real-time alert notifications, video clip playback for anomaly validation, and interactive dashboards for monitoring crowd density, staff performance, and equipment status. Basic web technologies like **HTML5**, **CSS3**, and **JavaScript (ES6)** will be used for interactivity and accessibility.

1. **Backend**

The backend will use **Node.js** for handling asynchronous operations and **Flask** or **Django** to integrate the machine learning models with business logic. APIs will be developed using **Express.js** to enable seamless communication between the frontend and backend. Key backend features include real-time alert processing, anomaly detection integration, and user authentication with role-based access control for secure operations.

1. **Database**

Structured data such as user logs and alert histories will be stored in **MySQL** or **PostgreSQL**, while unstructured data like video metadata will use **MongoDB**. The database will support centralized storage for anomaly clips and scalable data management, ensuring fast retrieval of historical records for reporting and analysis.

1. **Machine Learning**

The core of the project is powered by ResNet50 (CNN) for real-time anomaly detection. The models will be implemented using frameworks like TensorFlow or PyTorch and will leverage OpenCV for video preprocessing tasks such as frame extraction. ML algorithms will handle crime detection, crowd density estimation, and prediction of operational metrics, with adaptive learning to improve over time**.**

1. **Additional**

IoT integration will use sensors for additional real-time data collection, enhancing crowd and environmental monitoring. Notification systems like Twilio or Firebase will provide instant alerts via SMS or email, while WebSockets will enable real-time updates on the user interface. For video handling, FFmpeg will ensure efficient compression and streaming of anomaly clips**.**

**Hardware**

The system will require high-resolution IP cameras for clear video feeds and night-vision capabilities for round-the-clock monitoring. Processing will rely on **NVIDIA Jetson** devices or high-performance servers for running AI computations. An integrated audio alert system will trigger on-site alarms when anomalies are detected.

**End-User Devices**Control rooms will utilize desktop systems with access to centralized dashboards, while mobile devices like tablets and smartphones will allow security personnel to view alerts and video clips on the go. Smartwatches can also be used for instant vibration or audio alerts, enhancing mobility and responsiveness.

**Environment**

The development environment will include tools like **VS Code** or **PyCharm** for coding, with **Git/GitHub** for version control and collaboration. Deployment will rely on **Docker** for consistent application deployment and Linux-based servers for backend processing. Testing will be conducted using tools like **Postman** for API validation and **Selenium** for frontend testing.

**Abstract**

This project integrates Machine Learning (ML) and AI-powered analytics to enhance railway operations by analysing real-time CCTV footage for crime detection, crowd management, and work monitoring. Using models like ResNet50 and tools such as OpenCV, it identifies anomalies, triggers alerts, and provides actionable video clips to minimize false alarms. A comprehensive stack of frontend, backend, databases, and IoT integration ensures seamless functionality, while end-user devices like mobile dashboards and smartwatches enable efficient monitoring. Designed for scalability, this system aims to optimize safety, operational efficiency, and passenger experience within railway networks.

**End Users of the Platform**

1. The end users of this AI-powered railway surveillance platform include **security personnel**, **station administrators**, and **operational staff**. Security teams benefit from real-time alerts for crime detection and crowd management, enabling quick response to suspicious activities or overcrowding issues. They can access video clips of detected anomalies directly on their devices, reducing response time and improving incident validation. Station administrators leverage the platform’s analytics dashboard to monitor cleanliness, staff performance, and equipment health, ensuring operational efficiency and compliance with protocols.
2. Passengers indirectly benefit from enhanced safety and a smoother travel experience through real-time monitoring and proactive anomaly detection. The integrated alert system ensures timely assistance from emergency personnel like medical teams. The platform's mobile-friendly design supports on-the-go monitoring, and its scalability enables efficient deployment across multiple railway stations.

### **Advantages**

1. The platform consolidates essential interview tools, including video calling, collaborative code editors, whiteboards, and AI-driven report generation, enhancing user convenience for both interviewers and candidates.
2. It boosts interview productivity through real-time collaboration features like video calls, screen sharing, and interactive coding tools, enabling interviewers to assess candidate skills more effectively.
3. The platform streamlines the interview process from scheduling to report generation, significantly reducing the administrative workload for HR managers and interviewers.
4. Designed for adaptability, the platform provides solutions for businesses of all sizes, from startups to large enterprises, allowing users to customise the interview process to meet their specific needs.

**Conclusion**

The Platform platform is a cutting-edge solution aimed at modernising the interview process by incorporating real-time video communication, collaborative coding tools, AI-powered evaluations, and automated report generation. By utilising advanced technologies such as WebRTC, WebSockets, and AI algorithms, The Platform addresses the shortcomings of traditional platforms like Zoom and HireVue. The platform offers a seamless, efficient experience for both interviewers and candidates, streamlining the hiring workflow, improving assessment accuracy, and reducing the overall time and effort required for conducting technical interviews. With its intuitive interface and customizable features, The Platform serves as a comprehensive solution that enhances the entire interview process.