INVENTION DISCLOSURE FORM FOR PATENTS

Applicant Name-Marwadi University

1. **Particulars of Inventors**

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2. **Provide the title of the invention:** AI-Powered Train Safety System for Detecting and Rescuing Track Obstructions

3. **In 100 words or less, please provide an abstract or summary of the invention:-**

- This invention has created an AI-powered train safety system to prevent accidents involving living beings on railway tracks. A camera module mounted at the front of the train continuously scans the track in real time. Using advanced AI algorithms, the system detects the presence of humans or animals on the track even at high speeds. The system, when detecting, acts as a JCB-like mechanism that lifts carefully and places the living being aside from the track, ensuring no harm. That is a major solution to the limitations of regular train operation, where a train running at such high speed cannot be stopped in time to avoid collision. This system integrates AI detection and automated rescue mechanisms, enhancing railway safety, protecting lives, and reducing disruptions caused by track obstructions. It presents a practical and scalable solution for railway operations worldwide.

4. **Detail description of the invention:(Answers to all below are required in detail)**

   a. **Problem the invention is solving**
   - Highway and railway accidents due to humans and animals on tracks are a huge problem for all countries around the world, especially in those having large railway networks. The inability of high-speed trains to stop on time to avoid collisions results in tragic loss of life, injury, and disruptions in railway operations. Traditional solutions such as human

monitoring, signs, or fences are either ineffective or impractical across vast stretches of railway tracks.

- Major problems this invention addresses are as follows:

1) Safety Risks: High-speed trains cannot stop in time and thus cause accidents with animals and human beings.
2) Operational Inefficiency: The train schedule is conveniently delayed after the accident, investigation, and subsequently repair.
3) Economic Costs: The train crashes cause damage to trains, legal liabilities, and operational losses.
4) Environmental and Ethical Concerns: Killing of wildlife and ethical issues are left unresolved due to preventable accidents.
5) The equipment ensures that obstructions are proactively detected and evacuated without any adulteration to speed or safety of trains.

b. General Utility/application of the invention

➢ The invention is a safety solution for railways that is transformative, offering wide applications and utilities:

1) Railway Safety Enhancement:
- Prevents accidents of humans and animals on tracks.
- Reduces the risk of fatalities, injuries, and the moral or ethical questions of animal harm.

2) Operational Efficiency:
- Ensures that trains do not experience interruptions in their movement due to obstructions.
- Reduces time delay as caused by track-related accidents.

3) Wildlife Conservation:
- Protected animals against train-facilitated deaths, especially when such railway tracks run through wildlife habitats.

4) Economic Benefits:
- Reduces cost on accident investigations, track repairs, as well as lawsuits.
- Protein damage to train infrastructure and on-board cargo.

5) International Relevance:
- It is suitable for high-speed rail, freight trains and for urban transit systems.
- It can also be applied in highly dense railway network or wildlife corridors.

6) Automation and Artificial Intelligence Implementation:
- It supports smart railway systems brought about by sophisticated AI and robotics aiming towards the vision of new transport technologies.

- This technology will certainly enhance railway safety and security in global dimensions.

c. Advantages of the invention disclosing about the increased efficiency/efficacy

1) Improved Safety
- Instant detection of persons ensures that accidents are avoided even before they happen.
- The auto-rescue system removes the obstruction without causing harm to humans or animals.

2) Improved Efficiency:-

- There is no tendency toward sudden braking, which is inadequate for the high speed of a train.
- Less chance of delays as accidents or track blockages will not hinder the train schedules.

3) Greater Accuracy:

- Due to AI, living being detection and classification are handled with great accuracy, thereby minimizing false positives and avoidable interventions.

4) Working Reliability:

- Provides a consistent and automatic solution not depending on human surveillance or intervention
- Reduces time and related expenses in case of accident-related track closure or train damage.

5) Cost-Effectiveness:

- Minimizes the costs incurred in train repair, medical liabilities, and operational disruptions
- Avoids expensive delays and lost revenues from accidents

6) Environmentally Friendly:

- Preserves wildlife and decreases ecological damage in areas where train tracks invade natural habitats.

7) Global Scalability:

- The system will thus be adaptable to different types of trains and geographical terrains, making it a versatile and universal remedy.

d. Best way of using the invention as well as possible variants

Best Way of Using the Invention

1) Installation of Camera Module:

- Mount high-resolution, AI-compatible cameras on the front of the train to capture a continuous view of the track.
- Use infrared or night-vision cameras for effective operation in low light or adverse weather conditions.

2) AI Algorithm Deployment:

- Employ a pre-trained AI model capable of detecting and classifying living beings such as humans and animals.
- Integrate the system with real-time processing to ensure immediate responses.

3) Activation of JCB-like Structure:

- Deploy a robotic arm or JCB-like structure at the front or sides of the train.
- Use precise sensors to lift and relocate the detected obstruction safely without harm.

4) Safety Protocols:

- Incorporate automatic alerts and communication with train control centers for continuous monitoring.
- Add manual override options for unforeseen circumstances.

Possible Variants

1. **Detection Modules:**

- **Thermal Imaging:** For improved accuracy in detecting living beings during nighttime or fog.
- **Lidar and Ultrasonic Sensors:** For enhanced depth perception and obstacle detection.

2. **Robotic Mechanism Variants:**

- **Multi-Axis Robotic Arm:** For precise and flexible movements.
- **Air Cushion Mechanism:** A non-contact method to push obstructions aside using air pressure.

3. **Train-Specific Customizations:**

- **Freight Trains:** Use a stronger arm to handle heavier obstructions.
- **High-Speed Trains:** Optimize systems for minimal aerodynamic drag.

4. **AI Algorithm Enhancements:**

- Train models to detect debris and other non-living obstructions to prevent damage to train wheels.
- Incorporate self-learning capabilities for adaptive performance over time.

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e. **Working on invention along with Drawing, schematics, and flow diagrams if required with complete explanations**

1. Detection Stage

- Camera Module:
  - A high-resolution, AI-compatible camera mounted on the train captures live feed of the track ahead.
  - The camera may include night-vision and thermal imaging capabilities for 24/7 operation.
- AI Algorithm:
  - The camera feed is processed in real-time by an onboard AI system.
  - The AI algorithm analyzes the video to detect living beings (humans or animals) using techniques such as object detection and image classification.
  - If a living being is detected, the system triggers an alert.

2. Decision Stage

- Obstacle Classification:
  - The AI determines the type of obstruction (human, animal, or non-living object).
  - The system prioritizes actions based on proximity, size, and movement of the detected object.
- System Check:
  - Ensures the train speed and obstacle distance are within operational parameters for the robotic arm to function safely.

3. Action Stage

- Activation of JCB-like Mechanism:
  - A robotic arm or JCB-like structure is deployed from the front of the train.
  - The arm moves towards the detected living being, carefully lifts it and places it safely at the side of the track.
- Sensors for Precision:
  - Sensors on the arm ensure precise movement and prevent injury to the living being.

4. Post-Action Stage

- System Reset:
  - After clearing the track, the robotic mechanism retracts to its original position.
  - The AI system continues to monitor for further obstructions.
- Reporting and Monitoring:
  - An automatic report is sent to the train control center, documenting the incident for records and further analysis.

5. **Have you conducted a Primary Patent Search? Yes / No (if yes, attach the patent search results):-** No

6. **Existing state-of-the-art and prior arts: (Brief background of the existing knowledge/product/process in the market)**

1. Track Monitoring Systems

- **Description:**
  - Existing solutions use surveillance cameras and sensors for manual or semi-automated monitoring of railway tracks.
  - Some systems employ thermal imaging and drones to detect animals or humans on tracks.
- **Limitations:**
  - Lack of real-time responsiveness at high train speeds.
  - Cannot actively remove obstructions, relying instead on warning signals or human intervention.

2. Fencing and Barriers

- **Description:**
  - Railways often deploy fences and barriers to prevent animals or humans from accessing tracks.
  - Wildlife corridors or underpasses are built in areas with frequent animal crossings.
- **Limitations:**
  - Ineffective across long or remote railway stretches.
  - Expensive and impractical for dense or underdeveloped networks.

3. Automatic Braking Systems

- **Description:**
  - Systems like Positive Train Control (PTC) or Automatic Train Protection (ATP) initiate emergency braking when an obstacle is detected.
- **Limitations:**
  - Braking alone is insufficient at high speeds, as trains cannot stop in time to prevent collisions.
  - No provision for safely removing obstructions.

4. Animal Detection Systems

- **Description:**
  - Wildlife detection systems, such as those used in India and Canada, alert train operators to the presence of animals on tracks.
- **Limitations:**
  - Depend on operator response, which may be delayed.
  - Focused solely on detection, with no mechanism for obstruction removal.

5. Robotic Track Cleaners

- **Description:**
  - Robots are used for clearing debris or snow from tracks in some rail networks.
- **Limitations:**
  - Designed for non-living obstructions only.
  - Operate at much slower speeds than trains, unsuitable for high-speed scenarios.

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7. **List out the known ways about how others have tried to solve the same or similar problems? Indicate the disadvantages of these approaches. In addition, please identify any prior art documentation or other material that explains or provides examples of such prior art efforts.**

S. No.	Existing state of art	Drawbacks in existing state of art	Overcome (how your invention is overcoming the drawback)
202241051292	RAILWAY TRACK MONITORING APPROACH TO DETECT THE BREAKAGE OF TRACK AND OBSTACLE DETECTION USING GSM	- It Only Monitors the train track and detects the obstacle.	- **AI-powered real-time detection and automated response** removes the need for human intervention. - The system detects living beings on the track and uses a robotic arm to actively remove them.
202027028280	TRAIN CONTROL SYSTEM AND OBSTACLE DETECTION DEVICE	- It only Detects the Obstacle in front of train using image processing.	- The proposed system is designed to not only detect the obstacle but also remove the obstacle using a robotic arm structure.

8. **List the Technical features and Elements of the invention along with the Description of your invention from start to end.**

1) AI-Powered Camera Module:

- Feature: The system is equipped with an AI-powered camera module that continuously scans the railway tracks ahead of the train.
- Description: The camera captures real-time footage of the track ahead and sends the images to an onboard AI processor. The AI algorithm processes the images to detect any living beings, such as animals or humans, on the tracks.

2) AI-Based Object Detection and Classification:

- Feature: The AI algorithm is trained to detect and classify living beings on the tracks.
- Description: The AI model uses machine learning techniques, such as image recognition and deep learning, to identify objects and differentiate between animals, humans, and other non-living objects, distinguishing between potential threats and irrelevant obstacles.

3) Real-Time Data Processing:

- Feature: The system processes the data in real-time to ensure immediate action.

- Description: The camera feeds are processed with minimal latency, allowing the system to detect a living being as soon as it enters the camera's field of view. The system must work in real-time for effective prevention of accidents at high speeds.

4) Robotic Arm for Track Clearance:

- Feature: A JCB-like robotic arm capable of lifting and moving living beings off the track.
- Description: Once the AI detects a living being on the track, the system activates the robotic arm. The robotic arm is designed to gently and safely lift the animal or person from the tracks and move them to a safe location by the side of the track.

5) Safety Mechanism for Obstacle Removal:

- Feature: The robotic arm incorporates safety features to ensure that the living beings are moved without injury.
- Description: The robotic arm is designed to handle the living beings with care, using padded, gentle gripping mechanisms that minimize the risk of injury to the animal or human during removal.

6) High-Speed Operation Compatibility:

- Feature: The system is designed to operate effectively even when the train is running at high speeds.
- Description: The camera and robotic arm system can respond to potential threats quickly, ensuring that the intervention happens before a collision, even when the train is moving at high velocities (e.g., 100+ km/h).

7) Power Supply System:

- Feature: The system includes a reliable and efficient power supply that ensures continuous operation.
- Description: The camera and robotic arm are powered by a battery or an onboard power system, capable of supporting the high demands of the system without interruption. The power system ensures consistent operation throughout long-distance travel.

8) Communication System:

- Feature: Wireless communication capabilities for remote monitoring and control.
- Description: The system is capable of sending real-time alerts to train operators about the action being taken, or if the system fails to act properly. It could also provide data logs for analysis after a situation is handled.

9) Environmental Adaptability:

- Feature: The system is built to work in diverse weather and environmental conditions.
- Description: The camera modules are weatherproof and equipped with infrared or thermal imaging capabilities to detect living beings even in low visibility conditions such as fog, rain, or night time.

9. List out the features of your invention which are believed to be new and distinguish them over the closest technology.

1) AI-Powered Real-Time Detection System:

- New Feature: The invention utilizes an AI-powered camera module that can detect living beings on the track in real-time, continuously scanning for potential threats.
    - Distinction: Unlike existing systems that focus only on obstacle detection or simply send alerts to human operators, this system automatically detects and classifies the living beings (animals or humans) on the track, removing the need for human intervention.

2) Automated Track Clearance with Robotic Arm:

- New Feature: The invention incorporates a JCB-like robotic arm designed to automatically lift and move living beings off the track to a safe location.
- Distinction: Most existing systems focus only on alerting train operators or applying brakes to prevent collision but do not offer a physical solution for removing living beings from the tracks, particularly in real-time, high-speed scenarios.

3) High-Speed Operation Capability:

- New Feature: The system is engineered to function effectively even when the train is running at high speeds (e.g., over 100 km/h).
- Distinction: Existing technologies often focus on low-speed scenarios or are not optimized for quick intervention at high speeds. This system ensures that the track clearance happens within seconds of detection, allowing the train to avoid collisions without needing to decelerate or stop.

4) Real-Time Communication and Monitoring System:

- New Feature: The invention includes a real-time communication system that notifies train operators about the status of the track clearance, ensuring they are informed immediately.
- Distinction: Existing systems either rely on visual alerts or notifications that are not integrated with automated systems, whereas this invention provides continuous communication during operation, making it more responsive and transparent to train operators.

5) Safety-First Robotic Arm Design:

- New Feature: The robotic arm is specifically designed with soft, padded grippers that handle the living being gently to prevent injury during track clearance.
- Distinction: Many robotic systems focus on debris clearance but do not prioritize human and animal safety during the process, which can lead to injury. The careful design of the arm in this system addresses safety concerns for both the track and the living being.

6) Infrared and Thermal Imaging for Low-Visibility Conditions:

- New Feature: The camera module is equipped with infrared and thermal imaging capabilities to detect living beings even under low visibility conditions (fog, rain, night-time).
- Distinction: Most existing systems only use visible light cameras, which can be ineffective in poor visibility conditions. This feature ensures that the system can operate under a wide range of environmental conditions, increasing reliability.

7) Self-Sustaining Power System:

- New Feature: The system is powered by a high-efficiency battery or onboard power supply designed to ensure continuous operation without interruptions, even during long-distance travel.
- Distinction: Existing systems often face issues with power consumption or depend on external sources of power, making them less reliable for continuous operation. This invention's energy-efficient design enables uninterrupted functionality.

10. Has the invention been built or tested or implemented? If yes please provide the Efficiency/Efficacy details of the invention :- No

11. Briefly state when and how you first conceived this idea?

- I first conceived the idea for this invention after considering the critical issue of preventing accidents involving trains and living beings on the tracks, especially in high-speed environments. The inspiration struck while reflecting on the frequent reports of animal or human-related accidents on railway tracks, where stopping the train in time is impossible due to the high speeds at which trains travel.
- I realized that while technology has made significant strides in obstacle detection, there was still a gap in automating not just detection but also action, specifically for living beings on the tracks. Traditional systems mostly rely on train operators reacting to alerts, which can be delayed, especially when trains are moving at high speeds.
- The idea of using an AI-powered camera system combined with a robotic arm for real-time, automated intervention emerged as a potential solution to not only detect but also remove the living beings from the tracks in time to prevent collisions. This concept was further refined and developed into a full-fledged invention with the goal of improving train safety and preventing avoidable fatalities.

12. Have you sold, offered for sale, publicly used or published anything related to this invention? If yes, please briefly explain the dates and circumstances. List those individuals to whom you have revealed your invention. Were non-discloser documents signed prior to discloser in each case? Please state any deadlines of which you may be aware for filing an application on this invention. :- No

13. Include any reasons that your invention would not have been obvious to someone of average skill in the art.

1) Integration of AI with Automated Track Clearance:

- While AI-powered detection systems for obstacles on tracks are not entirely new, the concept of combining **AI-based real-time detection** with an **automated robotic arm** to physically move living beings off the tracks is a novel approach. Existing technologies typically either focus on **alerting operators** or **braking systems** for collision prevention, but they do not combine detection with an immediate **physical solution** to remove animals or humans from the tracks. This combination of AI with robotic intervention requires a level of cross-disciplinary innovation that is not immediately obvious.

2) High-Speed Operation in Real-Time:

- The invention's ability to operate effectively at **high speeds**, where both the detection system and robotic arm must function with precision, presents a challenge not addressed by existing systems. Most existing safety technologies are designed for slower environments or rely on human intervention, making the real-time execution of a track clearance system at high speed non-trivial. The problem of handling moving living beings in such dynamic conditions is a complex challenge that is not immediately obvious to someone skilled only in traditional train safety technologies.

3) Safety and Gentle Handling of Living Beings:

- The invention's **robotic arm design** includes **soft, padded grippers** to safely move living beings without causing harm. Designing a robotic arm that can handle living beings gently, while also being strong enough to clear obstacles from the tracks, is a nuanced task that requires specific engineering knowledge, and such

designs are not common in existing robotic track clearing systems. This focus on safety in handling living beings, particularly animals, is not typical in existing robotic solutions, making it non-obvious.

4) Adaptability to Environmental Conditions:

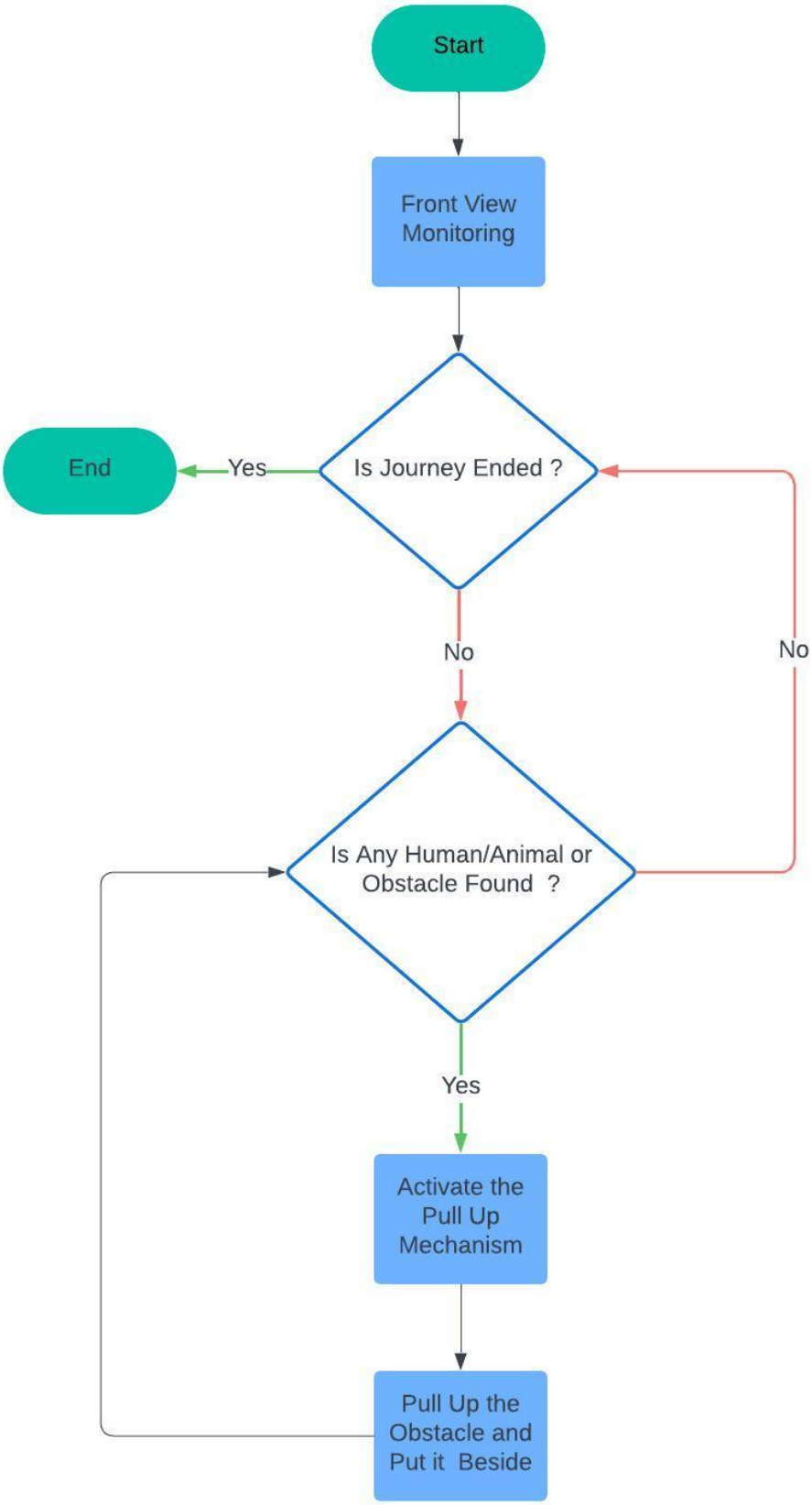
- The system's use of **infrared and thermal imaging** to detect living beings in low-visibility conditions such as fog, rain, or night-time operations is another feature that sets it apart from existing systems. While thermal cameras are used in other fields, the integration of such technology in a **high-speed railway setting** to function reliably and instantly is not obvious to someone working in traditional railway safety technologies.

5) Self-Sustaining Power System:

- Ensuring that the system operates independently for long durations without interruption from external power sources requires advanced knowledge of energy-efficient designs and systems integration. Existing animal detection or train collision systems generally don't prioritize this level of **self-sustainability**, especially under high operational demands like those of a moving train.

14. Additional comments by inventor (if you want to give more details out of scope of this IDF).

15. Drawings/Flowchart/Table



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