iRAMA_AI - Intelligent Road Asset Monitoring & Assessment

Edge-AI platform for real-time road condition monitoring

SAFETRIP Lab, IIT Roorkee

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and

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Supported By:

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विज्ञान एवं प्रौद्योगिकी विभाग
DEPARTMENT OF
SCIENCE & TECHNOLOGY

The National Challenge

India loses nearly **₹4.3 lakh crore** every year due to road issues, approximately 3% of India's GDP.

Current road surveys **are costly, inconsistent, and manual** (once or twice a year, most on highways).

Result: **late repairs, higher lifecycle cost, and unsafe roads**

Lack of **digital road health and asset management system**.

Vision & Mission

Digitize India's Roads through AI & Edge Computing.

Deliver real-time geo-referenced road data for smart mobility

"From Manual Inspection to Intelligent Monitoring"

Our Solution

iRAMA Framework

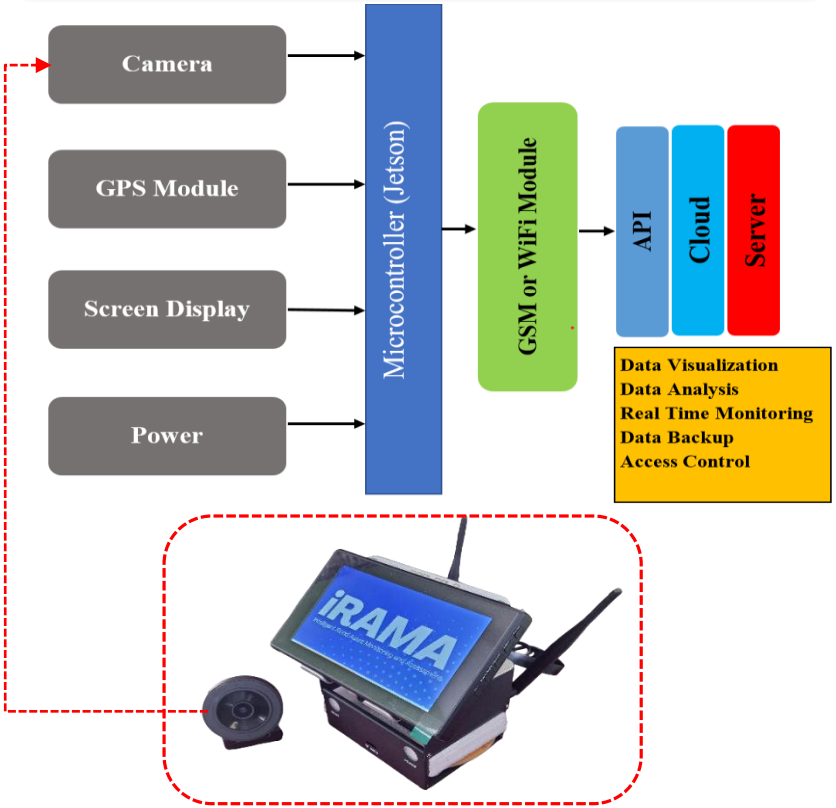
EDGE-AI DETECTION

GEO-TAGGING

DASHBOARD

Unified Edge-AI + Cloud Dashboard Framework

Hardware Innovation



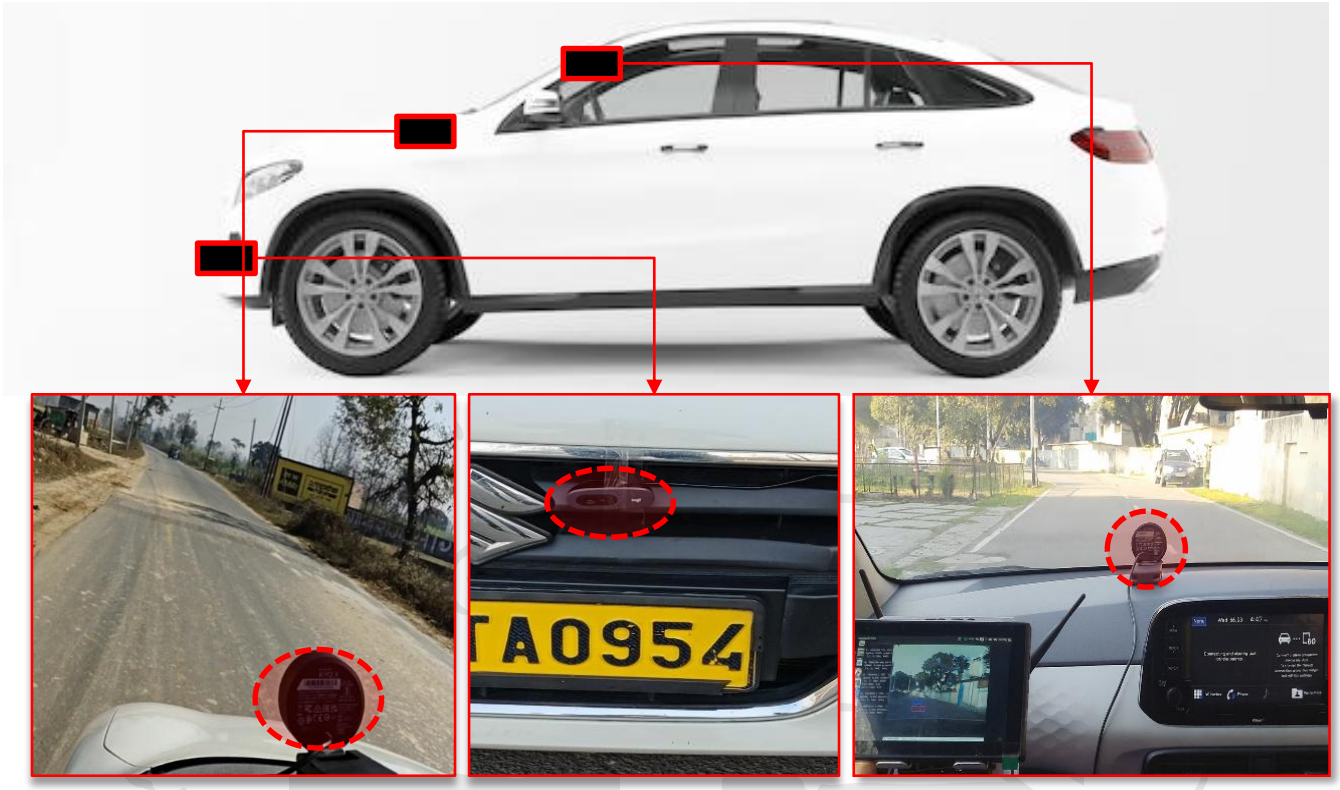
Edge-AI Device Architecture

- ❑ NVIDIA GPU-based edge processor
- ❑ HD camera and GPS Module
- ❑ 7” touch display for GUI and control
- ❑ 4G GSM / Wi-Fi connectivity
- ❑ Hybrid power system (car + internal UPS)

Key Features

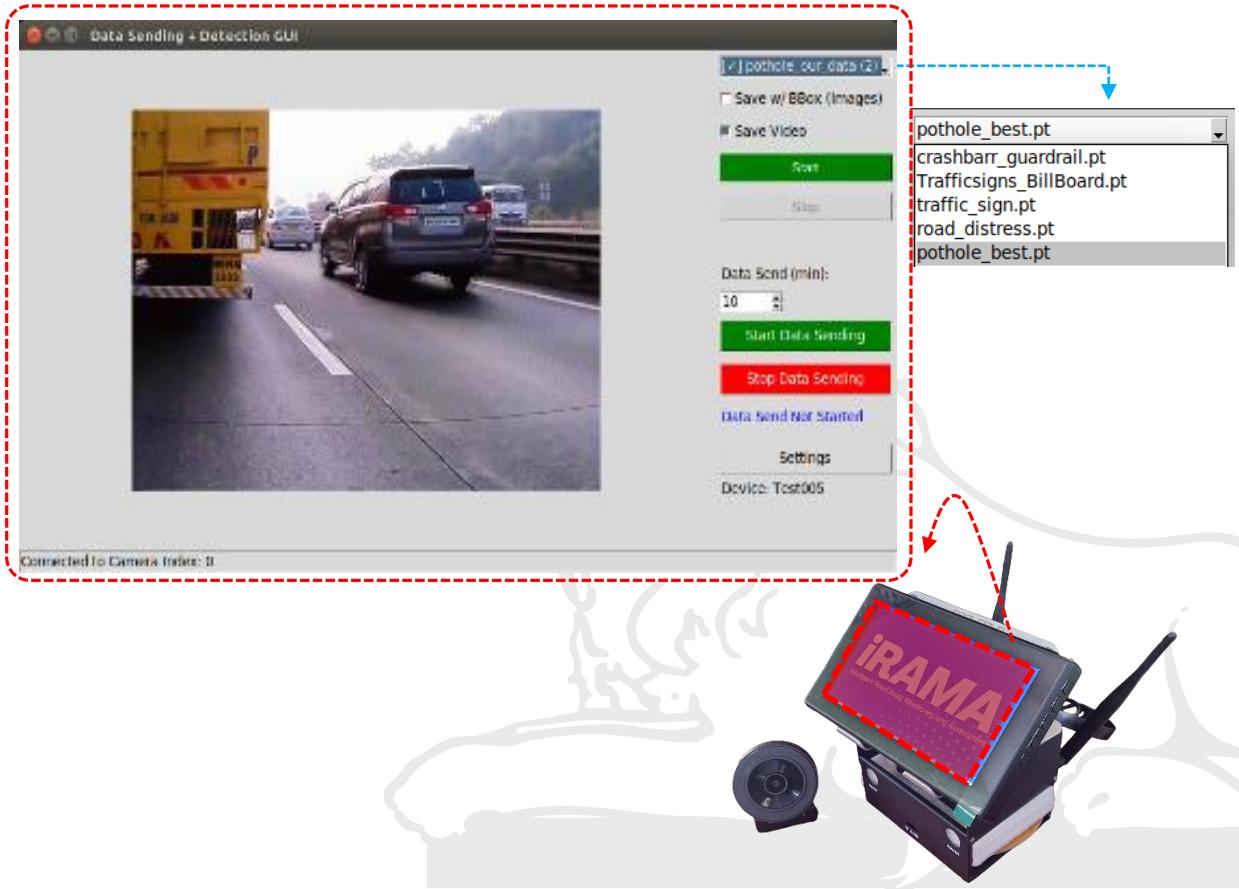
- ❑ Real-time AI detection & geo-tagging
- ❑ Edge inference > 10 FPS
- ❑ Secure cloud data sync
- ❑ Portable and vehicle-mounted design

Camera Mounting Strategy



Camera mounting positions: (a) windshield exterior, (b) front grille, and (c) dashboard interior.

On-Device GUI



User-friendly operation

- ❑ Automatic boot-up
- ❑ Model selection dropdown
- ❑ Live detection preview
- ❑ Configurable data upload:
  - ❑ Real-time
  - ❑ Interval-based
- ❑ Snapshot / video options

GUI for model selection, live feed display, and configurable data sending.

Field Deployment & Real-World Validation

Performance Highlights

- Detection accuracy > 80-90 % (multi-class)
- Real-time edge inference > 10 FPS
- Survey coverage ≈ 250 km/day per vehicle
- Hybrid power (vehicle + UPS)
  - zero downtime

TRL-7 Market-ready prototype

Validation & Outcomes

✓ Cross-checked against on-ground distress records

✓ Reliable under diverse city traffic & weather conditions

Privacy-protected data, vehicles and people automatically blurred before cloud upload

Detection Coverage & Anomaly Flags

• What We Detect • What We Flag

Road Distresses

- ❑ Potholes; alligator & longitudinal cracks
- ❑ Faded lane markings & crosswalks

Covers
15+ classes

Road Assets

- ❑ Traffic signs — **Warning / Mandatory / Informatory**
- ❑ Crash barriers & guardrails
- ❑ Manholes

Asset Anomalies

- ❑ Damaged / missing **traffic signs**
- ❑ Damaged **guardrails / crash barriers**
- ❑ Open / damaged manholes

All detections are **geo-tagged & time-stamped** for action and audit.

Detection Coverage & Anomaly Flags

• What We Detect • What We Flag

S No	1
Type	Pothole
Details	N/A
Timestamp	2025-12-04 13:15:04
Location	29.695893, 77.849572
DeviceID	IR006

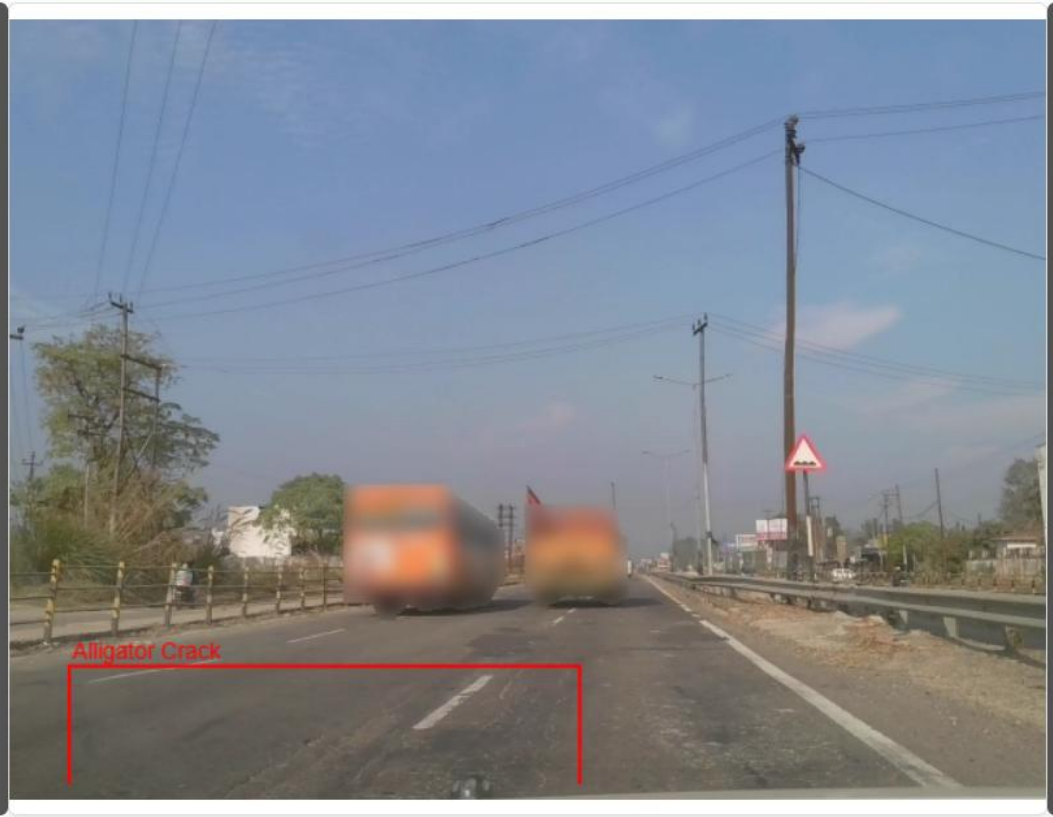
Detection Coverage & Anomaly Flags

• What We Detect • What We Flag

S No	3
Type	Pothole
Details	N/A
Timestamp	2025-12-04 11:10:05
Location	29.041338, 77.685528
DeviceID	IR006

Detection Coverage & Anomaly Flags

• What We Detect • What We Flag



S No	2
Type	Alligator Crack
Details	N/A
Timestamp	2025-12-04 13:16:17
Location	29.705786, 77.849845
DeviceID	IR006

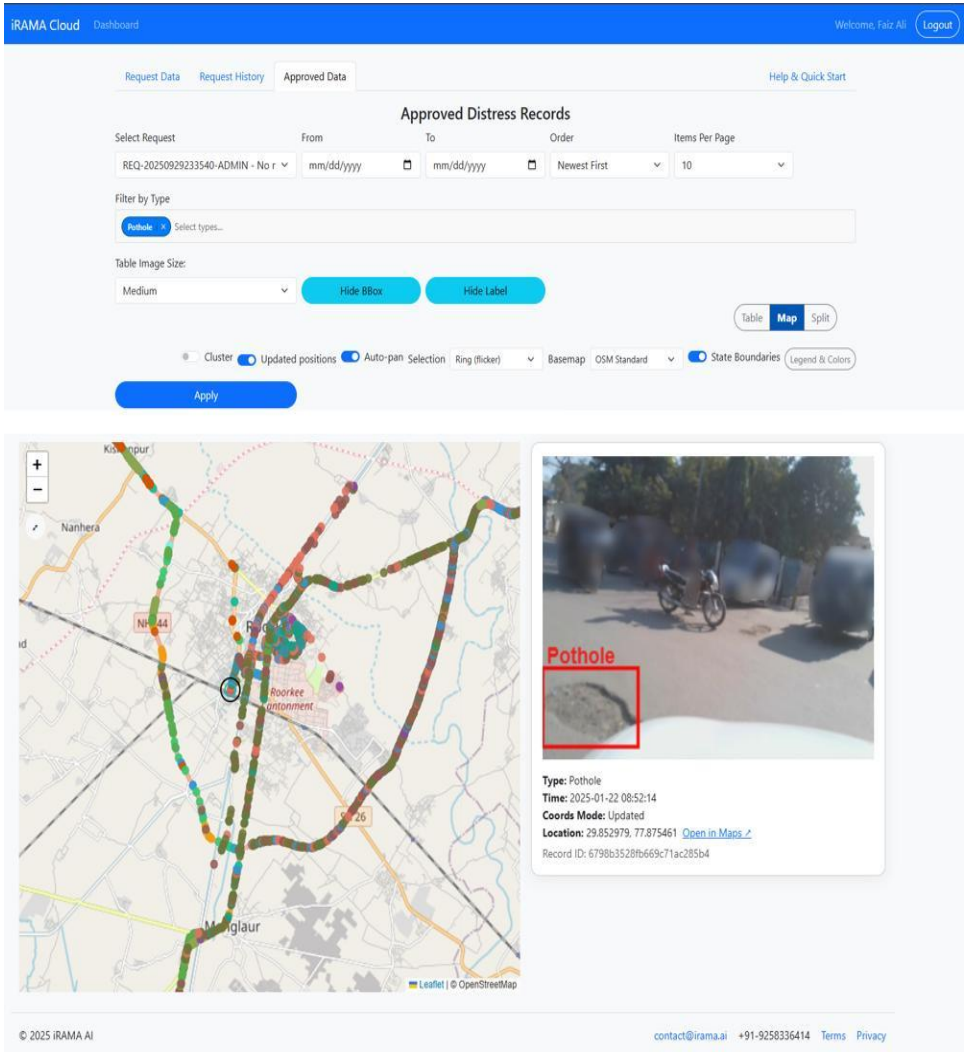
Detection Coverage & Anomaly Flags

• What We Detect • What We Flag

S No	4
Type	Advertisement Board
Details	N/A
Timestamp	2025-12-04 07:51:30
Location	28.625203, 77.311205
DeviceID	IR004

User-Specific Cloud Dashboard

Access, visualize, and download geo-referenced road data



Key Highlights:

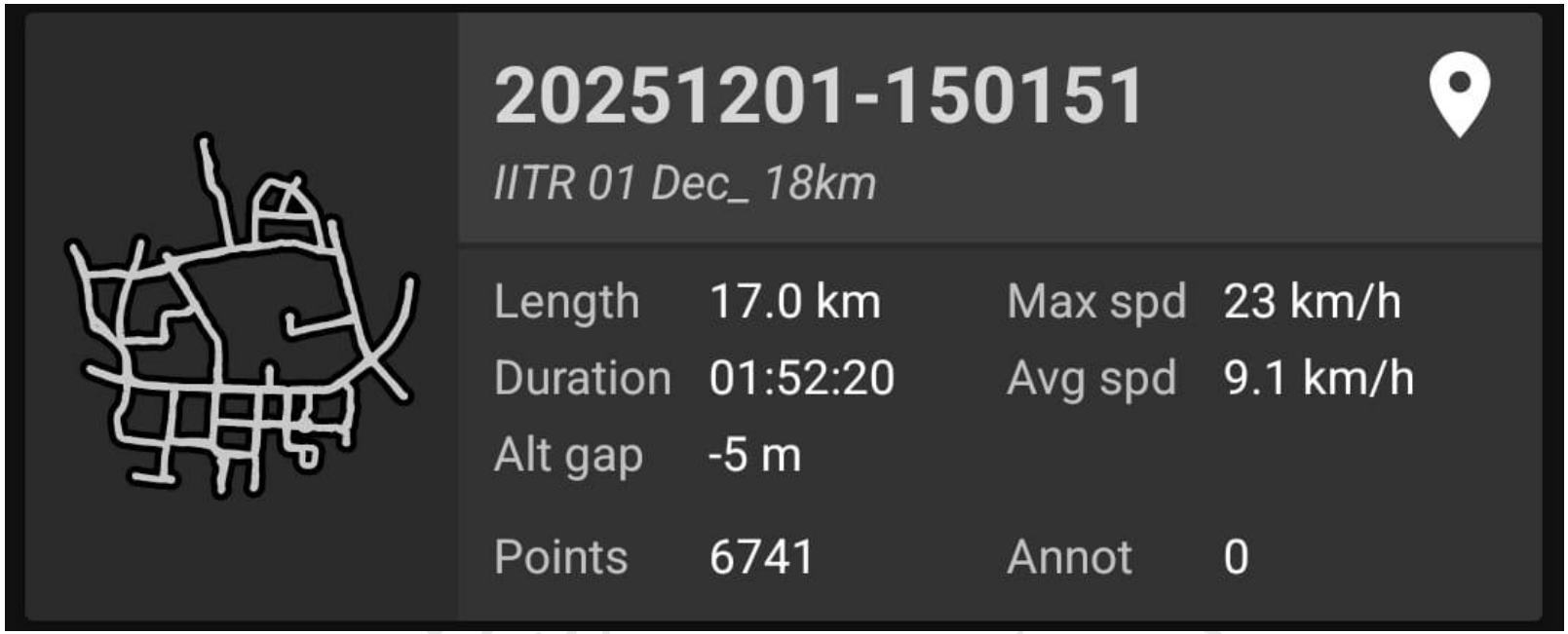
- **Client-specific portal**
- **Geo-tagged & timestamped**
- **Map & Table view**
- **Data request & download**
- **Filter by type, date, or survey route**
- Accessible through: cloud.irama.ai

Coming Soon:

Quantification (beta): pothole area/volume & assets anomaly metrics.

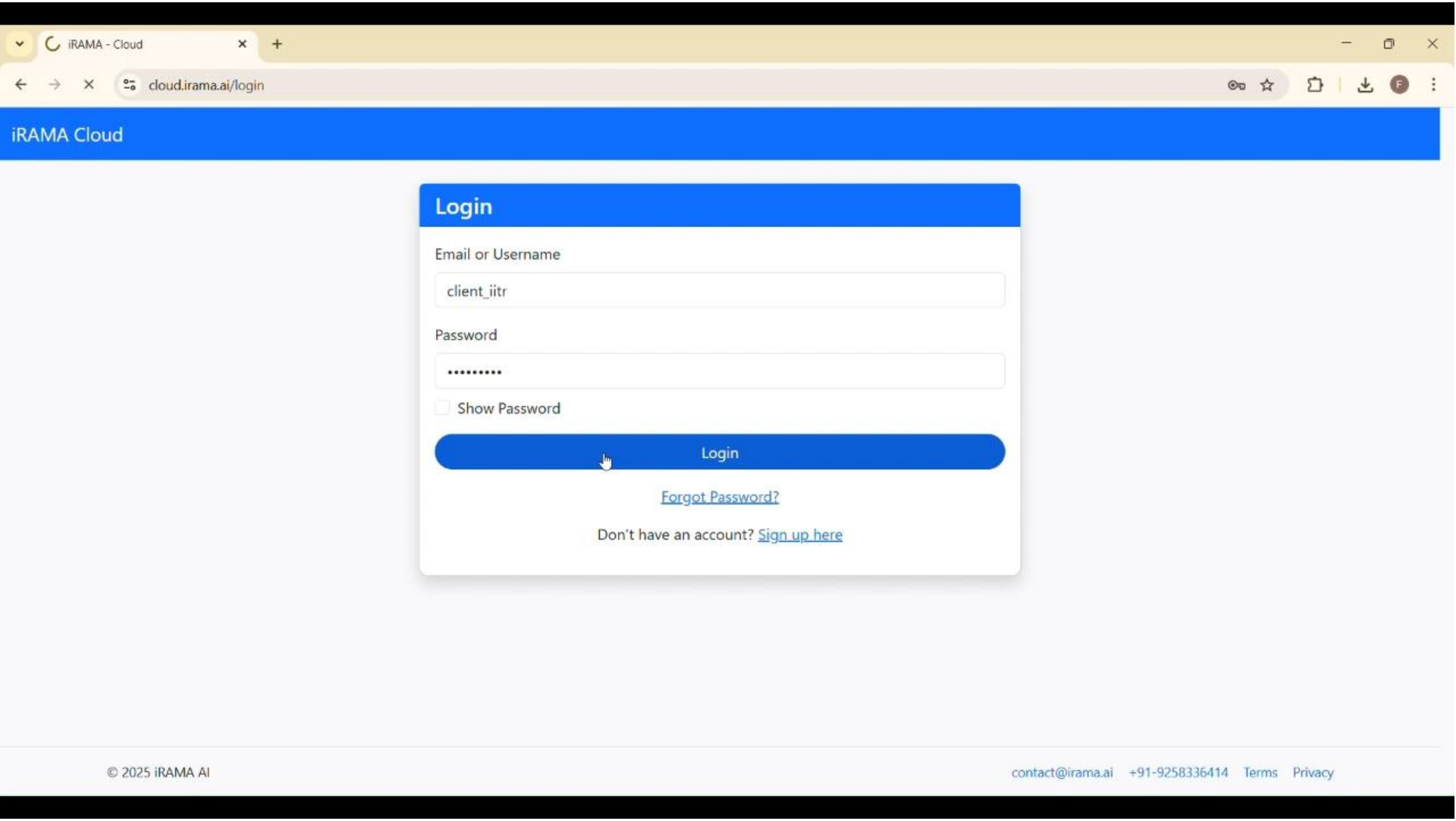
-City/ward-wise summary reports and citizen-reporting integration are in active development.

IIT Roorkee Campus Pilot: Geo-Referenced Mapping Output



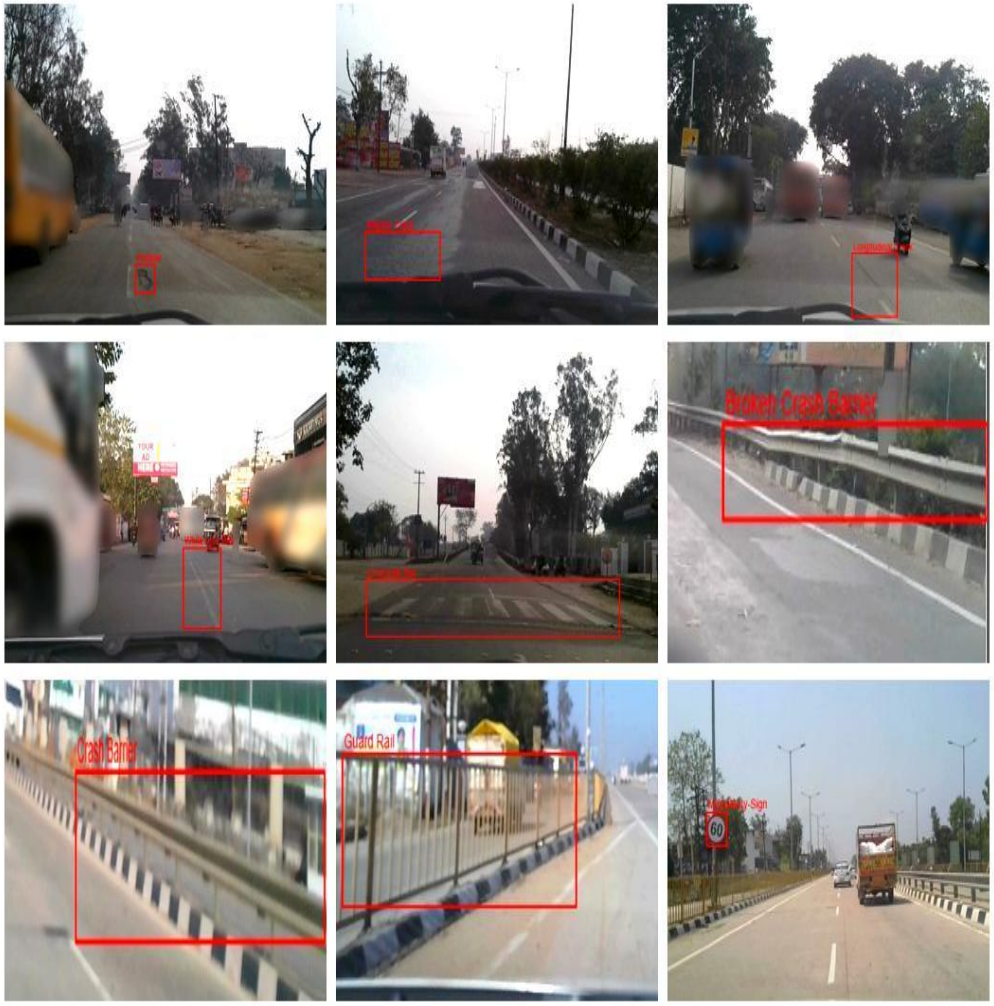
- Field pilot conducted on **IIT Roorkee campus** using the in-vehicle edge-AI system (camera + GPS + onboard inference).
- **Scale achieved: 15+ km** surveyed; **3500+ geo-referenced detections** generated as a GIS-ready inventory.
- Outputs available on dashboard: **route trace + map pins + image evidence** linked with GPS and time.

User Dashboard



Dataset & Road History: iRAMA-Net

A living, geo-referenced history of road health for Indian roads



25k+ Time-stamped, geo-referenced images for every survey run

Road-wise history, see how any location evolved across months/years

15+ classes: potholes, cracks, signs, guardrails & others

Accountability & Audits

Dataset supports **AI training, validation, and periodic model updates**

Patents & Publications

Research-Driven, IP-Secured Innovation

2 Indian Patents Filed & 4* Scientific Papers

Patents filed:

1. **Indian Patent App No. 202411085291 (***Published 13 Dec 2024***)**

Title: *Multi-Functional Intelligent Road Asset Monitoring & Assessment System with Integrated IoT*

2. **Indian Patent App No. 202511089592** *(Filed 2025)*

Title: *Single-Camera Pothole Volume/Area Estimation Method*

Publications & Presentations

1. **TRB 2024 – Washington DC**

Augmented Data & Detection Models for Real-Time Road Surveillance

2. **IEEE CONECCT 2024 – IISc Bengaluru**

Anomalous Traffic Sign Detection using YOLOv8 & SAM

3. **CTRG 2025 – IIT Guwahati (Presented)**

Road Anomaly Detection using IMU & GPS Data

4. **TRB 2026 – Washington DC (Presented)**

iRAMA-Net: Edge-AI Framework & Geo-Referenced Road Dataset (Recommended for TRR Publication, Sage Publications)

Our research has been **accepted for national & international conferences**, strengthening technical credibility.

Commercialization Potential

From Research Prototype → Market Deployment

Clients

- PWDs & Urban Local Bodies
- Smart City Agencies & Infrastructure Consultants
- Automotive & Mapping Companies (e.g., Ather, MapMyIndia, etc.)

Business Model

- On-Demand Surveys: city/route specific projects
- SaaS Dashboard (subscription)
- Data Services: download packs & API access

Stage

- **TRL-7** Market-ready prototype
- Field-tested for **800 + km** across diverse urban and highway conditions
- Deployment & support playbooks ready

Core Offerings

Client-specific, geo-tagged & time-stamped road data

Interactive dashboard & automated reports (pilot-ready)

API integration for pothole alerts & path optimization systems (pilot-ready)

Survey-as-a-Service using Edge-AI device and trained team

Empowering agencies and industries through AI-driven, on-demand road intelligence

Roadmap

Q1 phase started - **Jan 2026** • each quarter = **3 months**.

Q1

- Launch iRAMA.AI website & cloud.irama.ai portal
- Pilot deployments with partner agencies for testing
- Startup Registration

Q2

- Distress Quantification + model upgrade: Add Length/Area/Volume
- Automated analytics & reporting : ward/zone-wise condition scores

Q3

- Production edge device (sealed): pilot batch + remote updates
- Unit economics & Pricing finalised: ₹/km survey, device/data subscription

Q4

- Crowdsourced fleet: more vehicles > richer, faster road/city coverage
- Defect-to-fix app: push tasks > on site action > geo-tagged photo proof

* cloud.irama.ai is live (beta); milestones may overlap based on partner schedules.

Thank You

Digitizing India's Roads for a Safer Tomorrow

iRAMA.AI

SAFETRIP Lab
CED, IIT ROORKEE

Product site - iRAMA.AI

Scan for website

Lab site - SAFETRIP Lab

Scan for lab portfolio

Contact :

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Backup Slides

Team & ecosystem

Interdisciplinary 4-member core team spanning transportation, AI & IoT

Prof. Indrajit Ghosh (Faculty Advisor)
Professor, Civil Engineering Dept. &
Joint Faculty, Mehta Family School of Data Science and AI, IIT Roorkee
Head, SAFETRIP Lab, IIT Roorkee

Faiz Ali (Venture & IoT Lead)
Project Associate, IIT Roorkee
IoT & edge-AI hardware, system integration ***(full-time on iRAMA)***

Avnish Panwar (AI & Computer Vision Lead)
PhD Scholar, Mehta Family School of Data Science & AI, IIT Roorkee
Detection models & quantification pipeline

Dr. Kaliprasana Muduli (Transportation Domain Lead)
Postdoctoral Fellow, IIT Kharagpur; PhD (Pedestrain Safety using AI, IIT Roorkee)
Road distress area estimation, field trials & validation

Impact & SDG Alignment

Driving Societal Impact through AI & Innovation

INNOVATION | SAFETY | SUSTAINABILITY

AI-based road monitoring enables efficient infrastructure maintenance, supports Make-in-India innovation, and strengthens national mobility systems

Promotes safer, data-driven, and environmentally responsible urban transport networks, helping cities become smarter and more resilient.

Make-in-India AI technology for infrastructure monitoring

Reduced accident risk via proactive maintenance

Lower carbon footprint through optimized road repair

AI-driven road maintenance for safer, greener cities.

Unit Economics – iRAMA Device + SaaS

Cost Drivers

- **One-time hardware (aprox. Rs. 50k):** edge device, camera, GPS/IMU, screen, casing and vehicle installation
- **Recurring cloud & software (current aprox. 8k) :** storage, compute, dashboard, APIs, connectivity
- **Operations & support:** survey runs, field staff, maintenance, and periodic data labelling/model updates

Revenue & Value Drivers

- **Survey-as-a-Service fees** for a state or city or corridor-specific projects
- **Data / analytics / API access** for mapping and automotive partners
- For agencies: **lower effective inspection cost per km** and **better-targeted maintenance**, reducing lifecycle cost
- **Device + annual software subscription** (per vehicle / per km of network)

Competitive comparison

Why iRAMA vs Existing Approaches

Existing mobile / video survey solutions

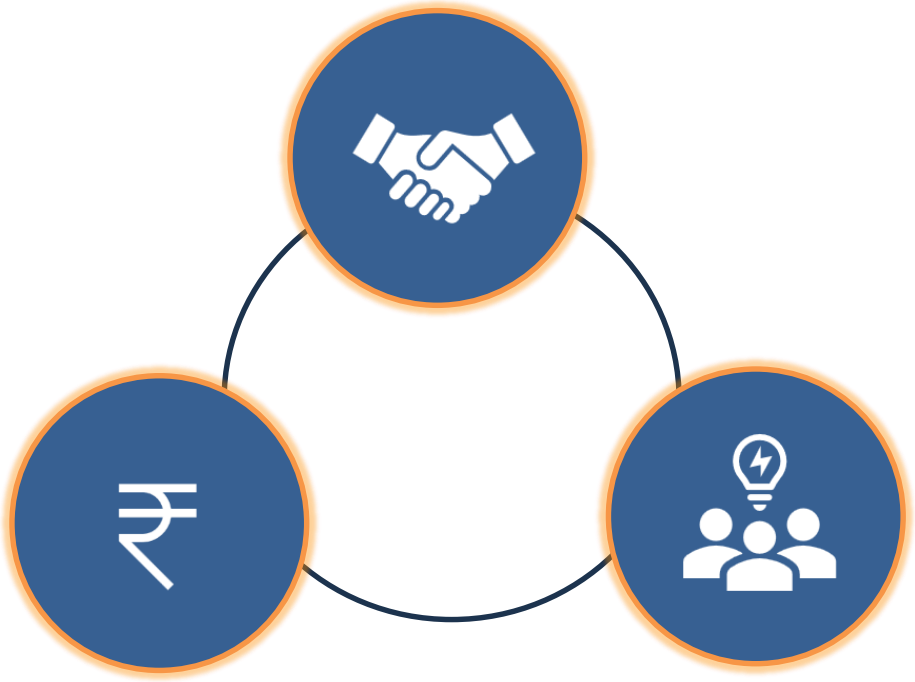
- Use **mobile or dash cameras to record video**, then do **offline post-survey analysis** in the office
- **Heavy manual effort**: large technical/analysis team needed to review footage and label events
- Hard to **scale to an entire state or full network** – processing load grows with every km
- Outputs are often **PDFs / Excel / raw videos** with **no structured road-wise history or central repo**
- Higher **cost per km** when coverage increases, because manpower and processing time go up

Our solution – iRAMA.AI

- **Edge-AI device processes video in real time** on the vehicle; only **geo-tagged events & images** are sent to cloud (complete road map possible)
- Designed to **scale to full-state networks** – simply add more devices; no huge back-office team needed
- Can run on **dedicated survey vehicles or fleets** (buses, utility vehicles) and even support **crowdsourced deployments**
- **Continuous mapping** possible – e.g., with ~10 devices, a fleet can cover **tens of thousands of km in a week** (depending on hours and routes)
- Data stored as a **structured, geo-referenced road history** with **role-based access**
  - State department can view **state-wide data**
  - Each urban local body sees **only its own area**

Collaborations & Support Sought

TRL 7-8, field-validated and ready to scale



Together, let's digitize India's roads.

We seek

- ❑ Launch platform
- ❑ Strategic Partners
- ❑ Pilots & Deployments
- ❑ Manufacturing & Infrastructure
- ❑ Recognition
- ❑ Market exposure

Patents filed

Office of the Controller General of Patents, Designs & Trade Marks
Department for Promotion of Industry and Internal Trade
Ministry of Commerce & Industry,
Government of India

सत्यमेव जयते

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

Application Details	
APPLICATION NUMBER	202411085291
APPLICATION TYPE	ORDINARY APPLICATION
DATE OF FILING	07/11/2024
APPLICANT NAME	**DIVYASAMPARK IHUB ROORKEE FOR DEVICES MATERIALS AND TECHNOLOGY FOUNDATION**
TITLE OF INVENTION	A MULTI-FUNCTIONAL INTELLIGENT ROAD ASSET MONITORING AND ASSESSMENT SYSTEM AND METHOD WITH INTEGRATED INTERNET OF THINGS (IOT)
FIELD OF INVENTION	ELECTRONICS
E-MAIL (As Per Record)	srmsvsrr@gmail.com
ADDITIONAL-EMAIL (As Per Record)	
E-MAIL (UPDATED Online)	
PRIORITY DATE	
REQUEST FOR EXAMINATION DATE	03/12/2024
PUBLICATION DATE (U/S 11A)	13/12/2024

Application Status	
APPLICATION STATUS	Application Awaiting Examination

Patents filed

Office of the Controller General of Patents, Designs & Trade Marks
Department for Promotion of Industry and Internal Trade
Ministry of Commerce & Industry,
Government of India

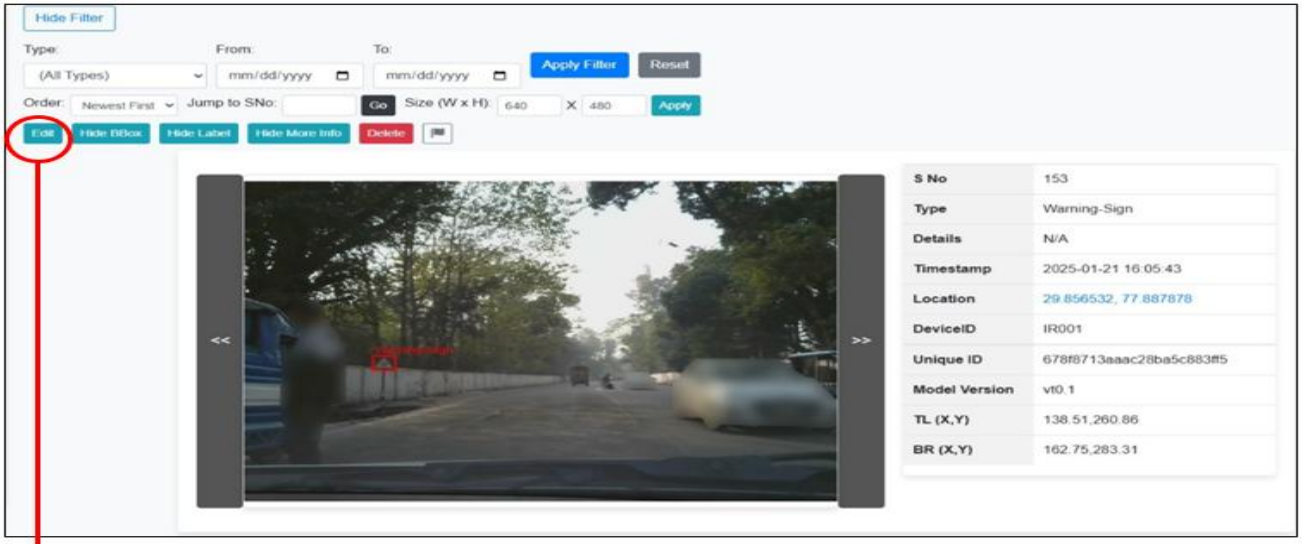
सत्यमेव जयते

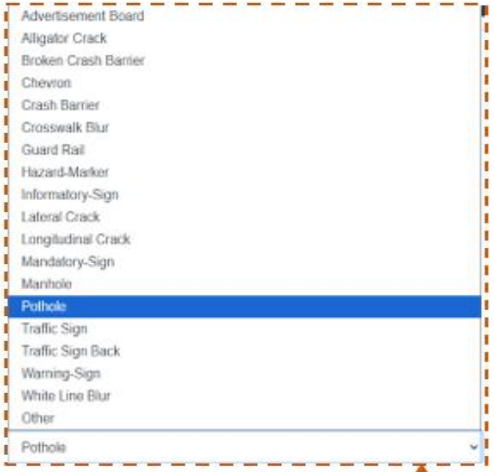
INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

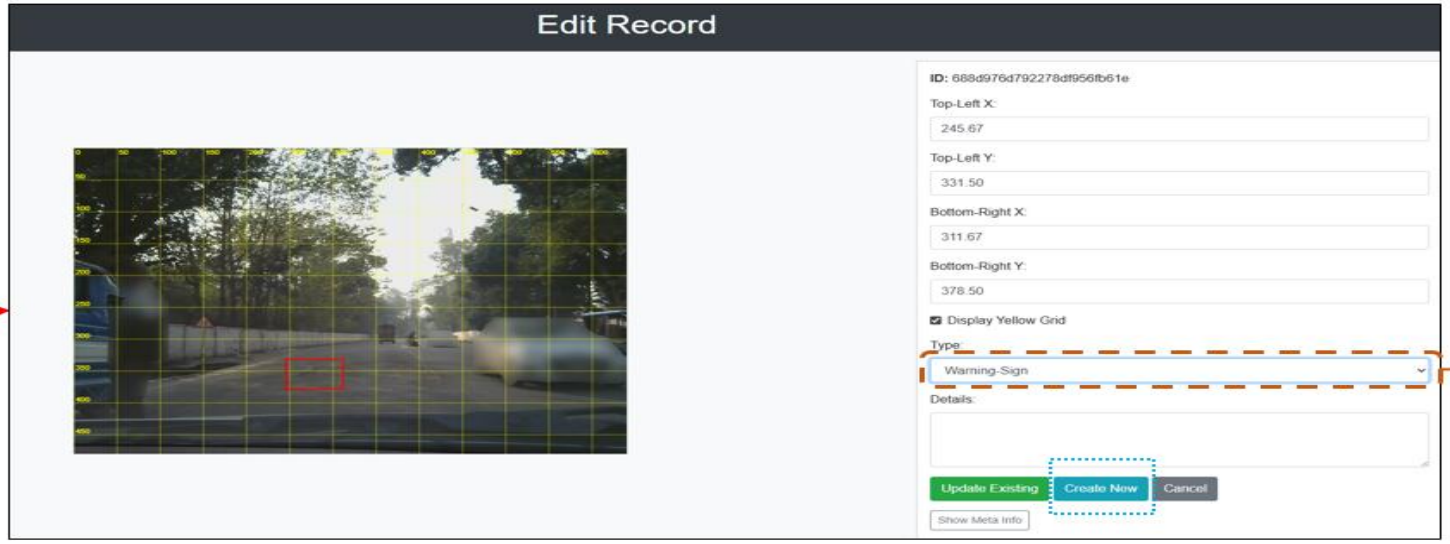
Application Details	
APPLICATION NUMBER	202511089592
APPLICATION TYPE	ORDINARY APPLICATION
DATE OF FILING	19/09/2025
APPLICANT NAME	**DIVYASAMPARK IHUB ROORKEE FOR DEVICES MATERIALS AND TECHNOLOGY FOUNDATION**
TITLE OF INVENTION	A REAL-TIME CAMERA-BASED SYSTEM AND METHOD FOR POTHOLE DETECTION, MAPPING AND QUANTIFICATION
FIELD OF INVENTION	COMPUTER SCIENCE
E-MAIL (As Per Record)	srmsvsrr@gmail.com
ADDITIONAL-EMAIL (As Per Record)	
E-MAIL (UPDATED Online)	
PRIORITY DATE	
REQUEST FOR EXAMINATION DATE	26/09/2025
PUBLICATION DATE (U/S 11A)	07/11/2025

Application Status	
APPLICATION STATUS	**Application Awaiting Examination**

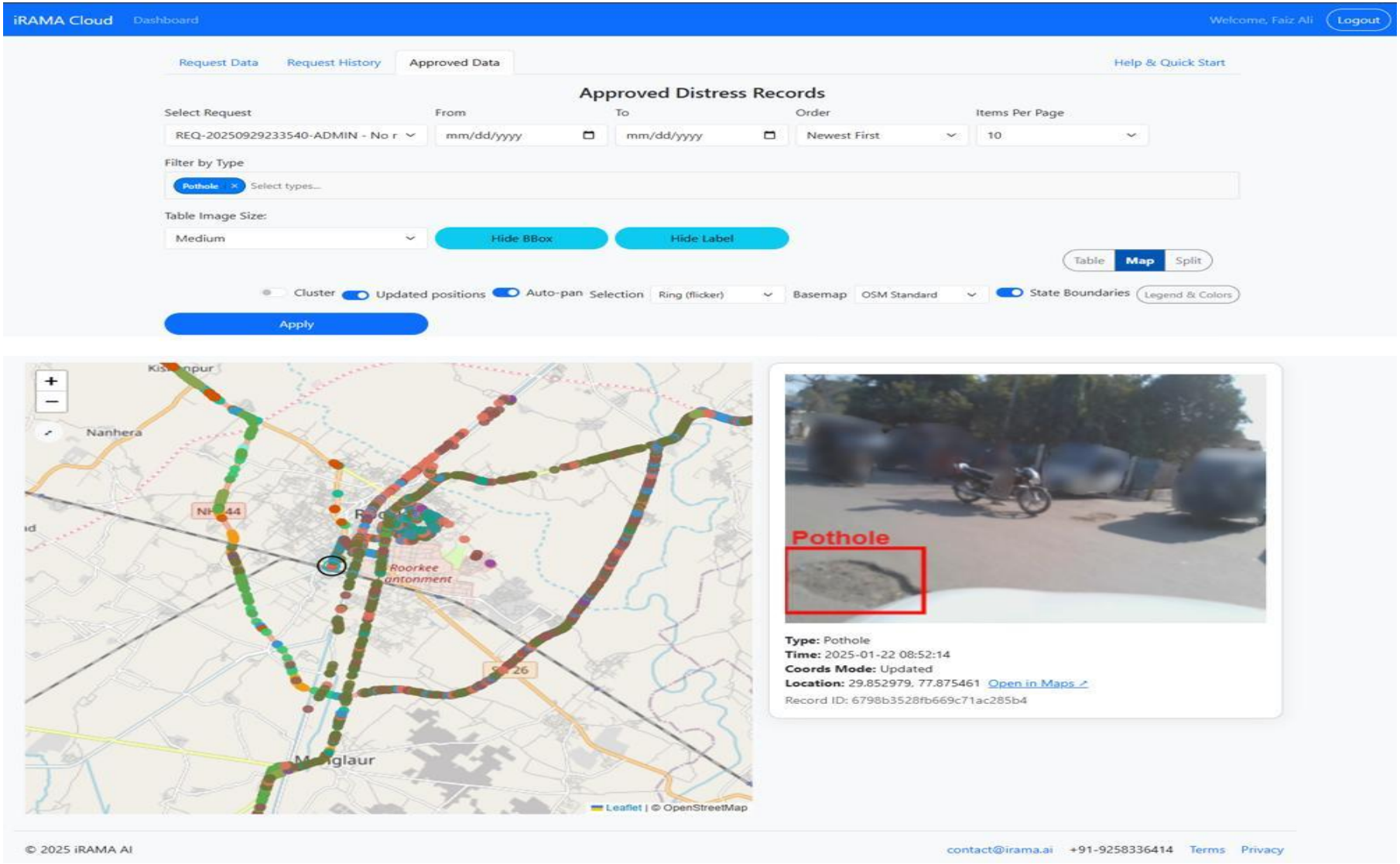
Human-in-Loop



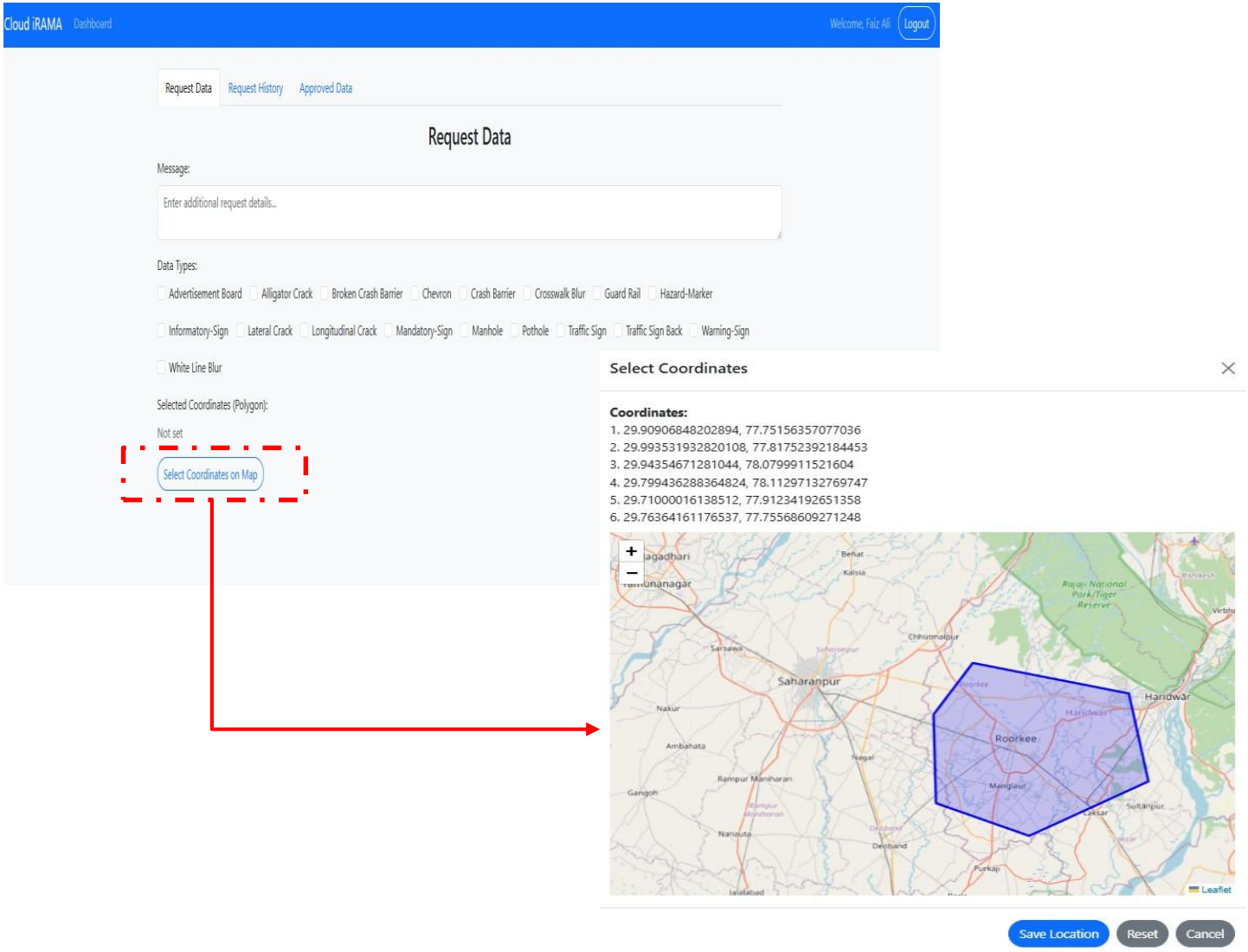




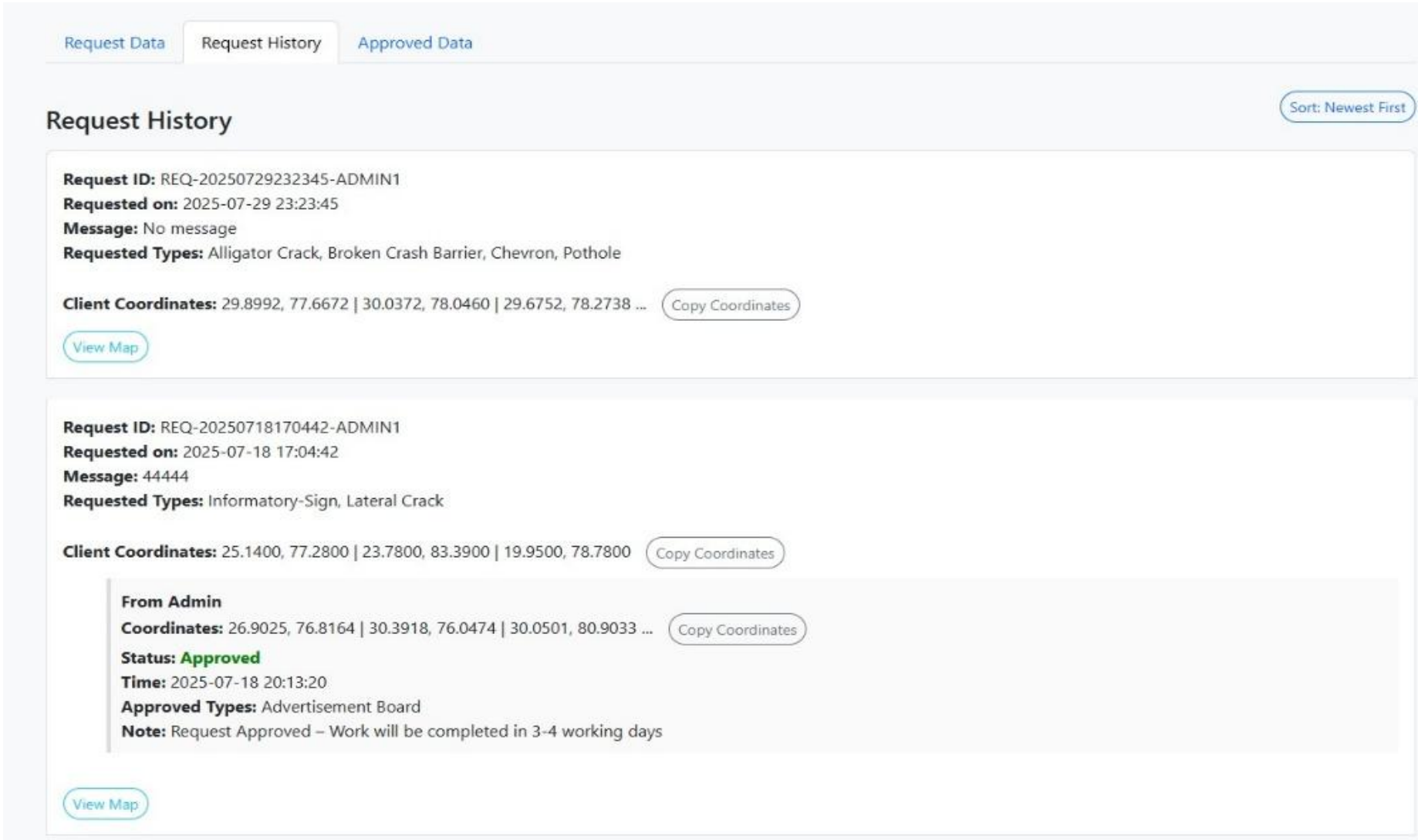
User Dashboard



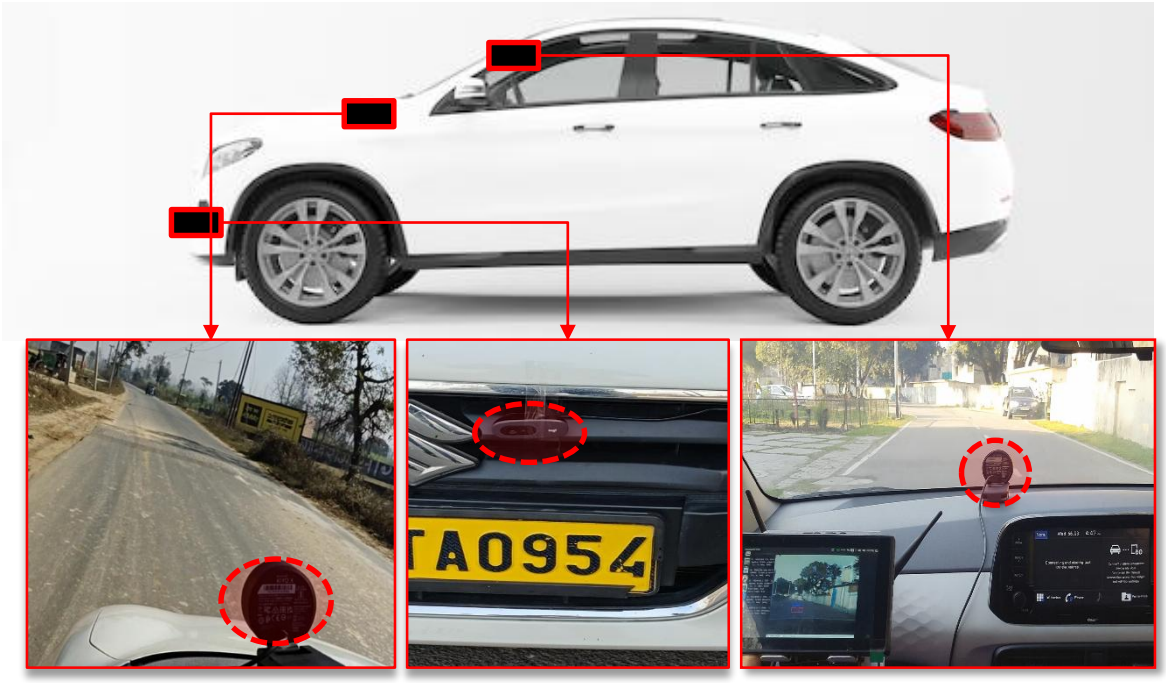
Specific Data - Area wise



History of Request

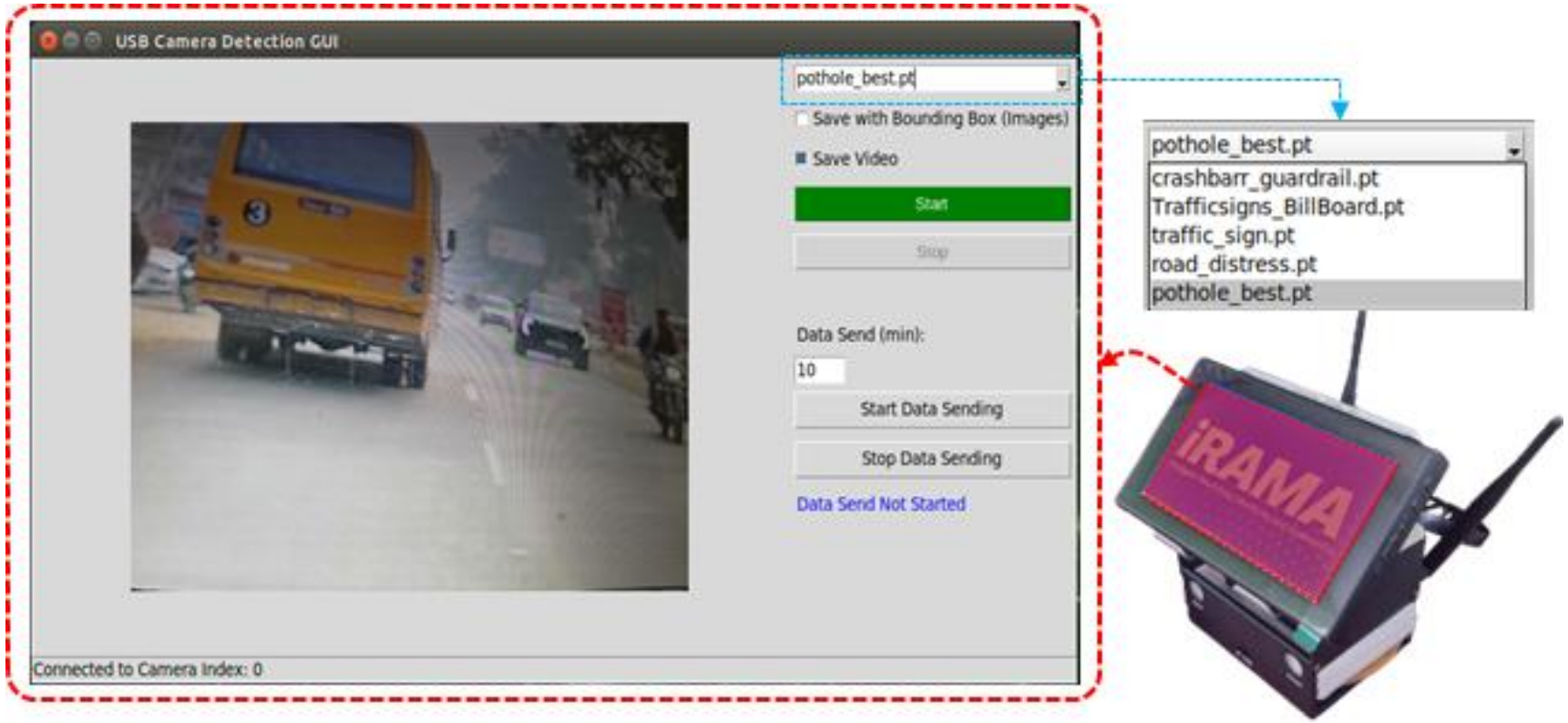


Camera Mounting



(a) (b) (c)

GUI - Device


USB Camera Detection GUI
pothole_best.pt
Save with Bounding Box (Images)
Save Video
Start
Stop
Data Send (min):
10
Start Data Sending
Stop Data Sending
Data Send Not Started
Connected to Camera Index: 0
pothole_best.pt
crashbarr_guardrail.pt
Trafficsigns_BillBoard.pt
traffic_sign.pt
road_distress.pt
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iRAMA