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UE22CS320A – Capstone Project Phase 2

Smart Reconnaissance System

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Outline

- Abstract and scope.
- Suggestions from phase-1
- Design Approach
- Design constraints, Assumptions and Dependencies
- Architecture
- Proposed methodology and Approach
- Datasets and Preprocessing
- Design Description
- Project Progress Plan for Phase 2

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ABSTRACT AND SCOPE

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Problem Statement

The SRS is proposed to autonomously conduct camera status checks, detect anomalous behaviour, minimize false positives, generate per-camera reports and alerts thus,raise alerts ensuring uninterrupted operation by harnessing advanced machine learning algorithms for real time data processing.

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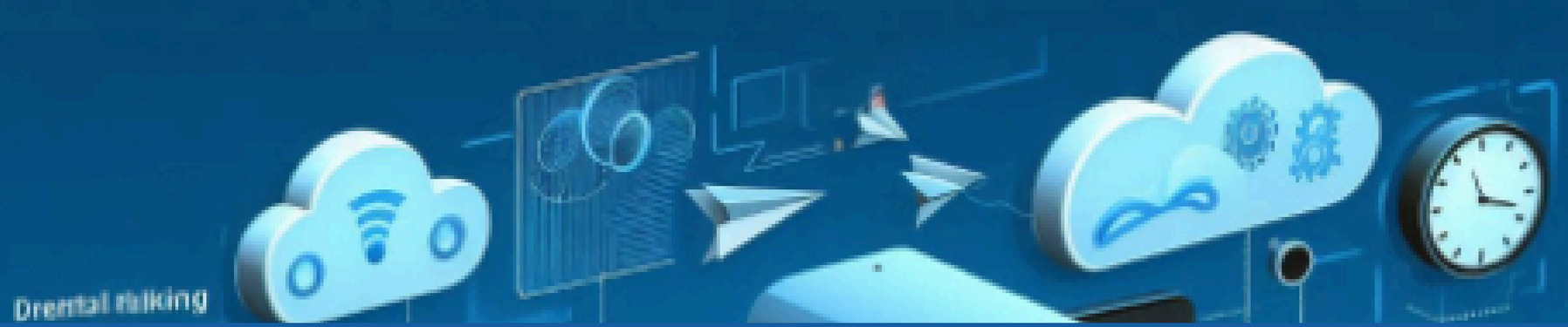
Introduction

- The **S**mart **R**econnaissance **S**ystem a.k.a **SRS** is a cutting-edge solution aimed at automating surveillance and enhancing security through real-time monitoring.
- By utilising machine learning and video analysis, the **SRS** ensures that cameras are fully operational and detects abnormal behaviour.
- This reduces the reliance on manual oversight and improves response times in critical situations.



Overview of the Scope

The scope of the **SRS** encompasses a diverse array of surveillance enhancements, like automated camera status verification, real-time video analysis, and the detection of objects and unusual activities

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SUGGESTIONS FROM PHASE-1

Suggestions from Phase-1

Crazy 8 Ideas

- Each member looked for 8 ideas that interests them.
- One idea from each member was selected based on majority voting.
- Each of the four ideas were discussed with our mentor and we collectively decided on the best one.
- The idea was improvised by adding some more features.

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Suggestions from Phase-1

- Generating a report for each individual camera.
- Monitoring each cameras health to know its status.
- Deciding the Non-functional parameters for the next phase.
- Read more papers relevant to our problem statement.
- Met Dr. Gayathri T, a Phd student who worked in this domain.
- Focus on surveillance on limited Locations.

Feasibility

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False Alarms

Usage of advanced machine learning models with continuous refinement and context-aware detection.

Data Storage

Scalable cloud storage and data compression.

System Failure

Usage of redundant systems, real-time monitoring, and failover mechanisms.

System Expansion

A modular architecture for easy expansion and integration of new cameras.

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DESIGN APPROACH

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Methodology & Philosophy

01

Modular & Scalable Design

- Independent hardware, network, and software modules.
- Ensures scalability

02

Event-Driven & Real-Time Processing

- Event-driven approach, where camera pings, failures, and anomalies trigger immediate actions

03

Hybrid Monitoring Strategy

- IP pings for connectivity checks
- Video-based detection for anomaly recognition

04

Automated Alerting & Feedback Loop

- Alerts are triggered based on connectivity failures or suspicious activity

05

User-Centric & Data-Driven Interface

- Dashboard provides real-time alerts, camera logs, and flagged anomalies

IMPLEMENTATION AND COMPONENT WORKFLOWS

1. **CAMERA REGISTRATION AND MONITORING**
   - Cameras are registered with a unique IP address and location
   - Cameras are pinged and video footage retrieved.
2. **FAILURE DETECTION AND CATEGORIZATION**
   - Non Responsive to 2 consecutive pings - camera marked
   - Anomalies in video footage identified
   - Camera Failure categorized
3. **AUTOMATED ALERTING AND WORKFLOW**
   - SMS alerts triggered for offline cameras or anomalies detected.
   - If unresolved, escalation to higher authorities
4. **ISSUE RESOLUTION AND FEEDBACK LOOP**
   - Personnel respond to alerts
   - Once resolved, the camera's status is updated.
   - System logs the resolution time and personnel performance
5. **REPORT GENERATION & ANALYSIS**
   - Periodic reports generated
   - Reports include resolution times, cause of issues, and security alerts

BENEFITS

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AUTOMATED ALERTS & ESCALATION

- SMS alerts ensure prompt attention to issues.
- Escalation workflow ensures unresolved problems reach higher authorities without delays.

DETAILED ANALYTICS

- Periodic reports provide insights into recurring issues, aiding in preventive maintenance and improved system design.

ENHANCED SECURITY ASSURANCE

- Quick issue resolution and data analysis improve surveillance reliability, reducing blind spots and potential security breaches.

DRAWBACKS

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DEPENDENCE ON NETWORK STABILITY

- Frequent pinging and video streaming require a stable network; poor connectivity may cause false positives or delays.

HIGH MAINTENANCE OVERHEAD

- Continuous monitoring, alerting, and reporting may demand significant infrastructure, increasing operational costs.

ESCALATION BOTTLENECKS

- If the escalation process is inefficient, unresolved issues may accumulate, affecting system reliability.

DESIGN CONSTRAINTS, DEPENDENCIES AND ASSUMPTIONS

DESIGN CONSTRAINTS

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Hardware Constraints	Software Constraints	Network Constraints	User Interface Constraints
Cameras must support high resolution & low latency. Storage efficiency needed for continuous recording	Real-time video processing with low delay.Efficient anomaly detection using AI.	High bandwidth required for video streams. Low-latency asynchronous communication for realtime alerts. Secure encryption for video transmission	Fast, intuitive UI for real-time monitoring. Scalable dashboard supporting multiple camera feeds.

DEPENDENCIES

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Legal Implications	Usage Limitations	Software & Hardware Requirements	Integration and Maintenance
Compliance with data privacy laws and local surveillance regulations.	Impact of environmental factors on accuracy and high computational requirements limit scalability.	Requires AI frameworks , IP enabled cameras, GPUs and large-scale storage solutions.	Needs seamless integration with existing security systems and regular updates to models, hardware, and compliance policies.

ASSUMPTIONS

Adequate Infrastructure	Data Availability for Training	Legal Compliance	Adaptability to Diverse Environments
Sufficient access to computational resources, like high-performance GPUs, large-scale storage, and stable network connectivity.	Sufficient availability of labelled data to train the model.	All the necessary legal permissions for surveillance have been obtained, and compliance with privacy regulations is maintained.	The AI models are assumed to adapt well to different environments and varying conditions.

ARCHITECTURE

ARCHITECTURE

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Client-Server Model

- Client-Server Model – IP-enabled CCTV cameras stream data and respond to periodic pings.
- The central monitoring system processes both ping responses and video feeds for anomaly detection.

Network Communication Layer

- Ping Setup: Cameras are pinged at intervals (e.g., 180 sec) to check connectivity.
- Video Processing: Selected footage is analyzed using machine learning models to detect unusual activity.

Database Layer

- Stores camera metadata, failure logs, flagged anomalies, and personnel details.

Automated Alerting System

- Alerts triggered based on ping failures or detected anomalies in video feeds.
- Escalation Path ensures unresolved issues are escalated to higher authorities.

Dashboard & Issue Resolution Module

- Real-time UI: Displays camera statuses, logs, and flagged anomaly events for administrators.
- Status Updates: Allows personnel to mark cameras as operational after issue resolution.

ARCHITECTURE

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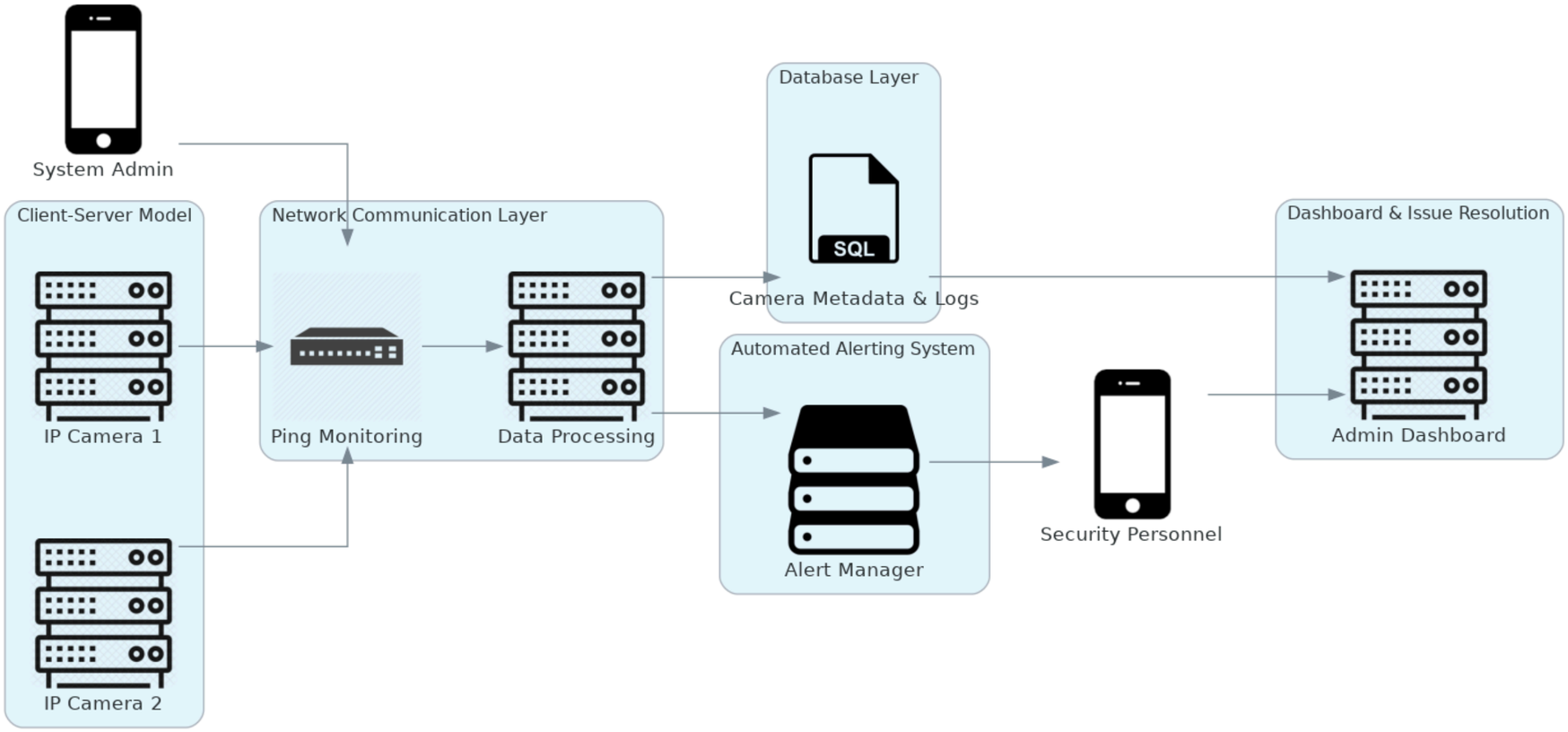

Smart Reconnaissance System

PROPOSED METHODOLOGY AND APPROACH

Proposed Methodology and Approach

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Planning & Requirement Analysis

- Define system requirements, workflow, and technology stack.
- Design a scalable client-server architecture for camera monitoring.

System Design & Development

- Ping-based monitoring for camera connectivity.
- Failure detection (offline, network, power issue).
- Automated alerts via SMS & escalation.
- Video anomaly detection using ML.
- Real-time dashboard for monitoring.

Testing & Performance Optimization

- Conduct unit testing, load testing, and performance tuning.
- Fix issues to ensure efficient real-time processing.

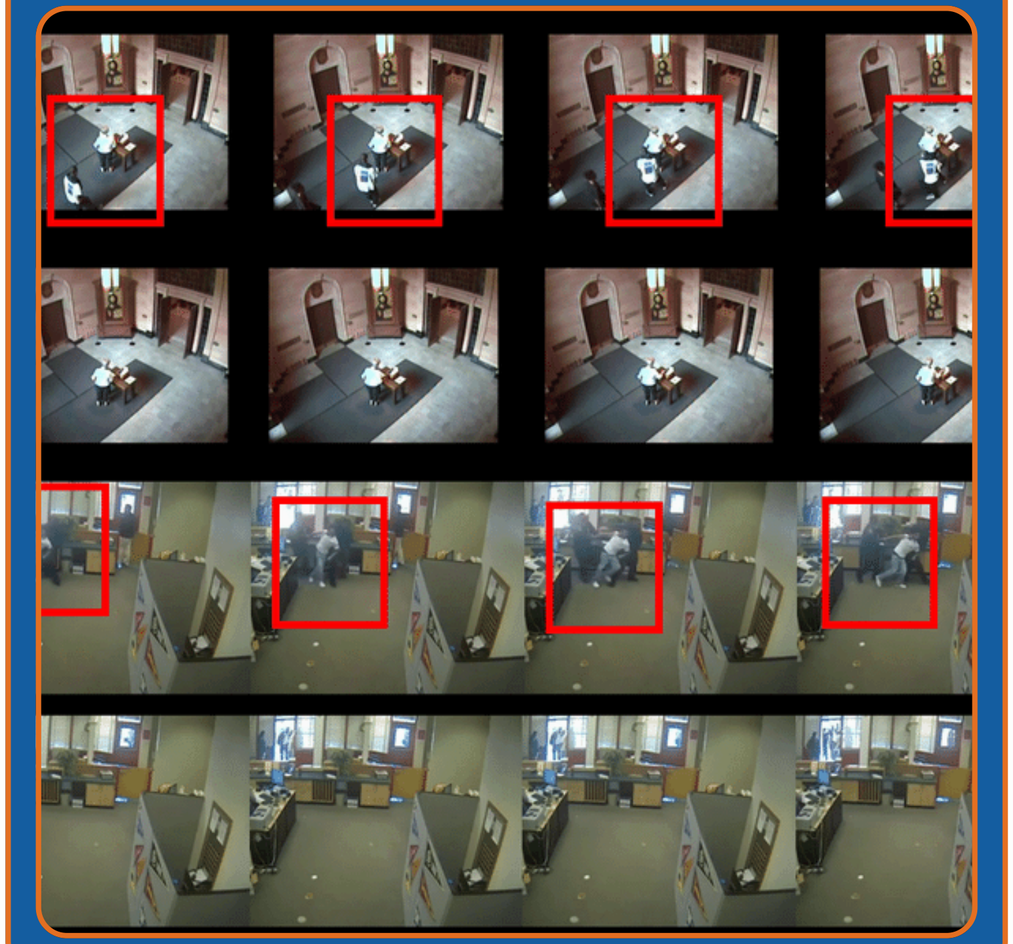
Deployment & Maintenance

- Deploy system in a real-world surveillance environment.
- Monitor performance, collect feedback, and update system as needed.

DATASET EXPLORATION

UCF Crime

- **Videos:** MP4/AVI
- **Annotations:** CSV/TXT (video-level labels)
- **Metadata:** File name, timestamp, crime type
- **Preprocessing:** Frame extraction and Resizing
- **Models:** CNN + LSTM



UCF Crime Dataset

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1,900+ real-world videos

Large-Scale Dataset

Anomaly Diversity

Covers fights and vandalism

Captured from CCTV cameras.

Real Surveillance Footage

Long Video Duration

Enables temporal anomaly analysis.

Supports binary & specific crime classification

Multi-Class Labels

UMN

- **Videos:** MP4
- **Annotations:** TXT (frame-level labels)
- **Metadata:** Scene ID, timestamps, activity type
- **Preprocessing:** Frame extraction, resizing, motion analysis
- **Models:** **CNN** + Optical Flows

UMN Dataset

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Crowd Panic Detection

Captures sudden dispersals and unusual movement patterns.

Indoor & Outdoor Footage

Suitable for cafeterias and public space surveillance.

Frame-Level Labels

Provides precise timestamps for normal-to-abnormal transitions.

Realistic Anomaly Progression

Shows gradual shifts from normal to abnormal behavior.

Multi-Scene Dataset

Covers hallways, grassy fields, and walkways for diversity.

ShanghaiTech

- **Videos:** MP4
- **Annotations:** MAT (pixel-level masks)
- **Metadata:** Scene ID, frame number, anomaly type
- **Preprocessing:** Frame extraction, normalization
- **Models:** CNN + Transformer models

ShanghaiTech Dataset

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Ideal for loitering, movement anomalies

Crowd Anomaly Detection

Normal & Abnormal Data

Trains balanced anomaly detection models.

Provides pixel-wise annotations for precision

Pixel-Level Labels

Early Threat Detection

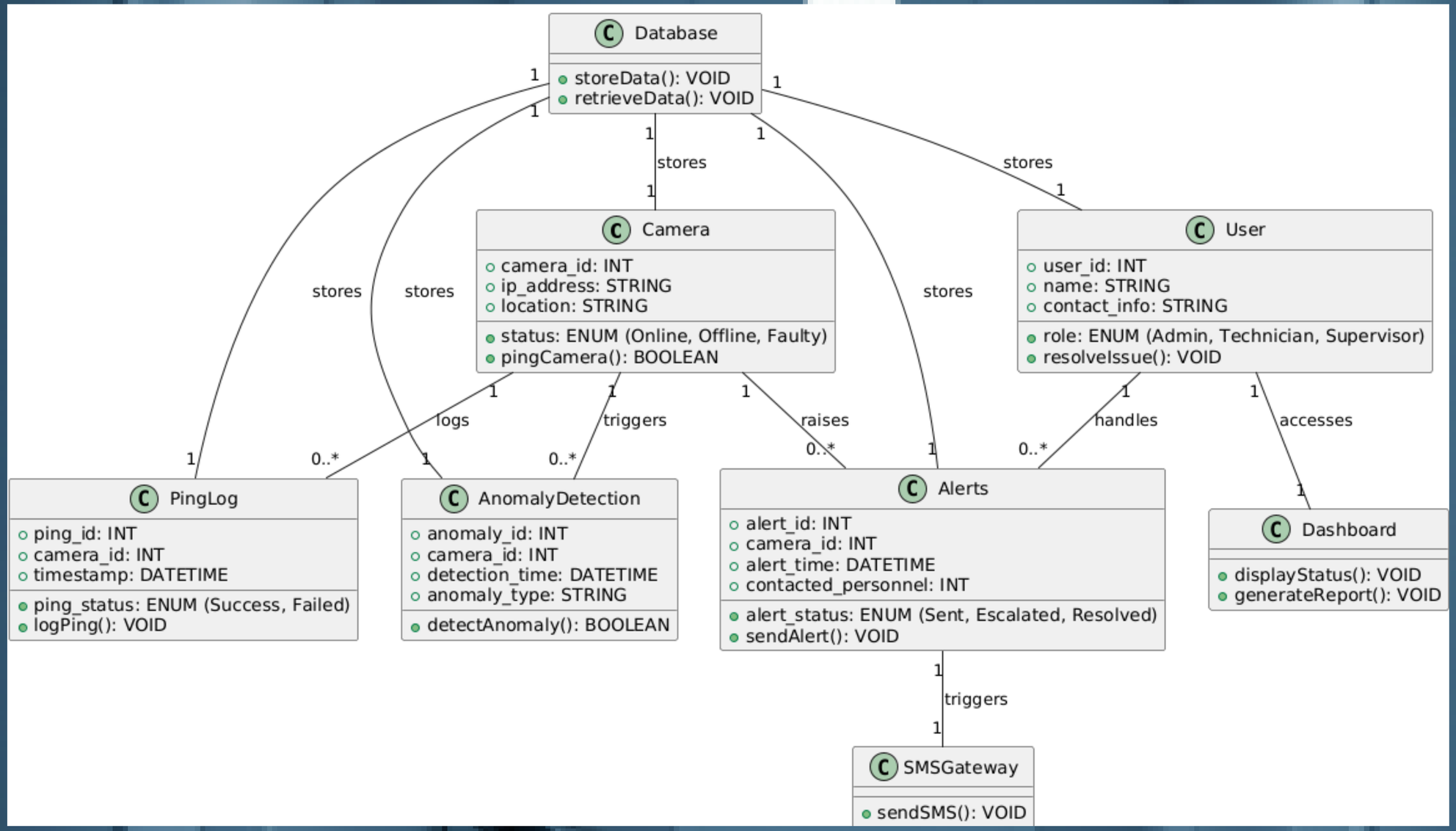
Helps identify issues before escalation

Covers 13 urban environments

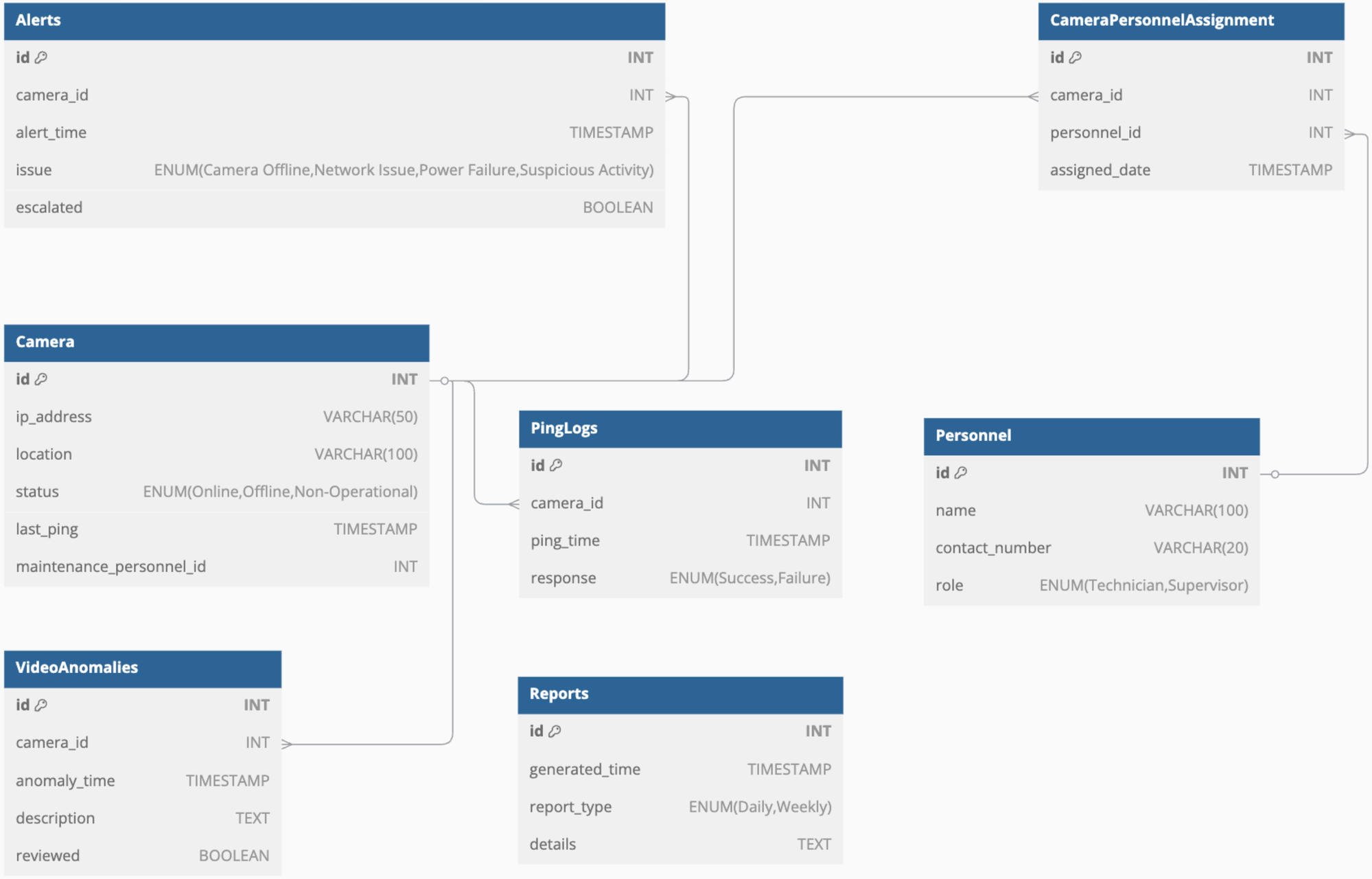
Multi-Scene Dataset

DESIGN DESCRIPTION

MASTER CLASS DIAGRAM



RELATIONAL SCHEMA



PROGRESS PLAN FOR PHASE 2

PROGRESS PLAN FOR PHASE 2
GANTT CHART

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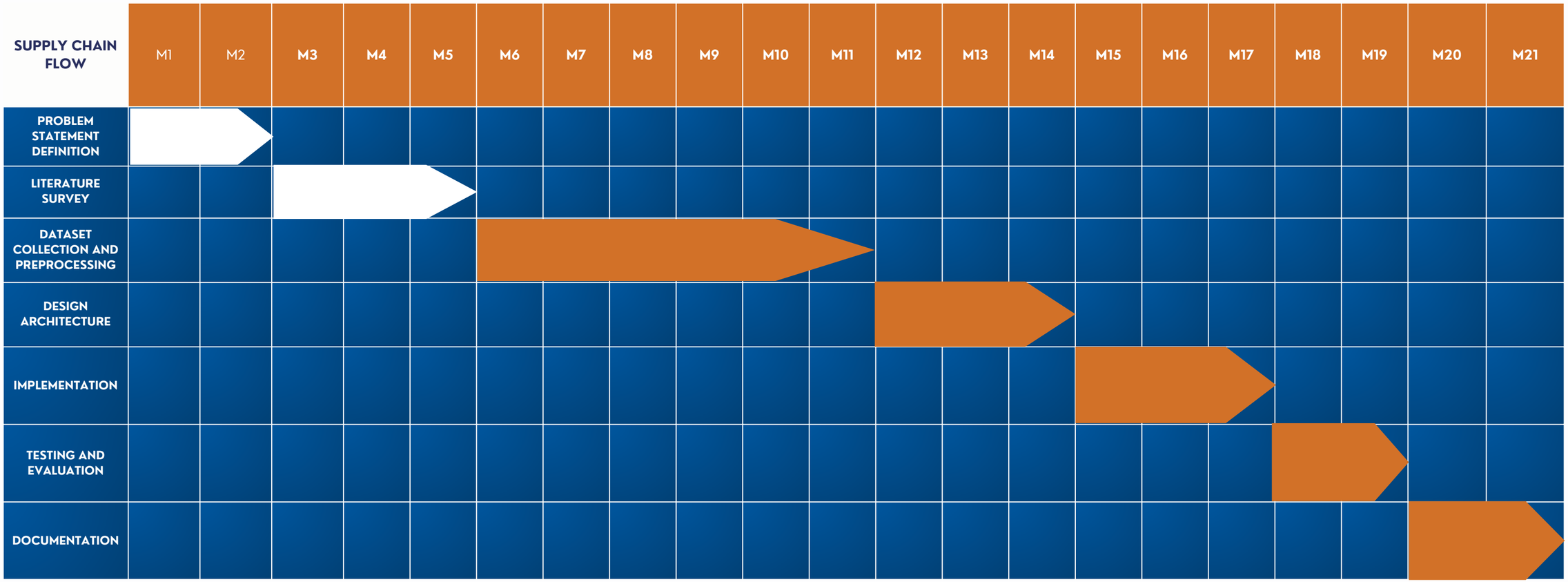

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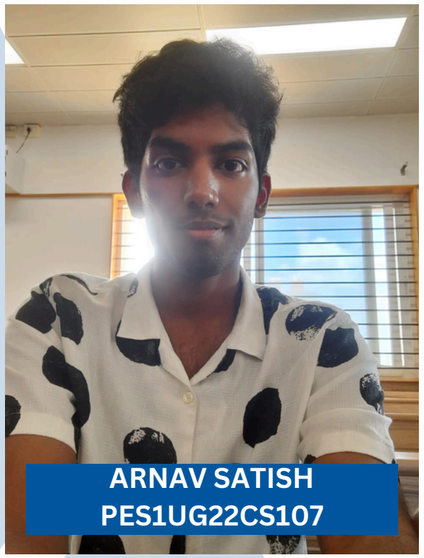
THANK YOU!



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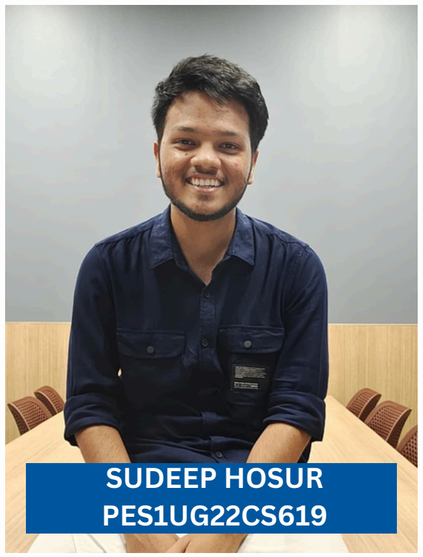

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