Real-Time Fire and Person Detection with Automated Notification Alerting Using CCTV Surveillance Footage

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CV Project Interim Presentation

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Problem statement, scope & users

Problem Statement:

- Rising fire incidents in urban & industrial areas threaten lives and property.
- Delayed detection increases damage; traditional systems lack real-time response.
- Need robust, automated fire & person detection for CCTV networks.

Scope:

- Develop a mobile app for real-time fire & person detection using YOLOv11n with notification alerting.
- Train on D-Fire Dataset and Human Dataset for fire and person detection respectively.
- Enable user uploads of live CCTV feeds & use real time camera.

Users:

- **Primary**: Building managers, security personnel monitoring CCTV systems.
- **Secondary**: Fire stations receiving automated alerts with location data.
- **End Users**: Residents, workers benefiting from early fire detection.

Related work

- **Traditional Approaches:**
  - Haar cascades & color-based methods: Fast but struggle with smoke variability (lighting, density).
  - Thresholding (e.g., RGB/HSV): Limited by false positives in complex scenes.

- **Early Deep Learning:**
  - CNNs (e.g., AlexNet, VGG): Image classification for fire/smoke; high accuracy, low speed.
  - Challenges: Not suited for real-time CCTV due to computational cost.

- **Modern YOLO-Based:**
  - YOLOv3: mAP ~0.7, faster but less precise for smoke (Li et al., 2019).
  - YOLOv5: mAP ~0.75–0.8, balances speed/accuracy (Khan et al., 2021).

- **Datasets:**
  - FireNet: Small-scale, controlled fire/smoke images.
  - D-Fire: Larger, diverse real-world scenarios (used in this work).
  - Human Dataset: Dataset of humans for detection.

Final Model

- **Model Selection:**
  - YOLOv11n (nano): 3M params, 8.2 GFLOPs; lightweight for real-time detection.

- **Training Setup:**
  - Dataset: D-Fire & Human
  - Hardware: NVIDIA RTX 4060 GPU, AMP enabled.
  - Config: 100 epochs, batch 16, 640x640 imgs.

- **Hyperparameters:**
  - Optimizer: SGD (lr=0.01, momentum=0.9).

- **Performance:**
  - mAP@0.5: 0.768, mAP@0.5:0.95: 0.446.
  - Class-Specific: Smoke: 0.834, Fire: 0.702, Person: 0.603.

Dataset & Evaluation Metrics

Dataset:

- [D-Fire Dataset](#):
    - **Training Set:** 14,122 images (6,458 without objects).
    - **Validation Set:** 3,099 images (1,375 without objects).
    - **Classes:** Smoke, Fire; real-world CCTV scenarios.
    - **Preprocessing:** Corrupt JPEGs restored.

- [Human Dataset](#):
    - **Training Set:** 13,800.
    - **Validation Set:** 4,000.
    - **Preprocessing:** Corrupt JPEGs restored.

Evaluation Metrics:

- **Precision:** 0.765 (overall detection confidence).
- **Recall:** 0.702 (proportion of true positives detected).
- **mAP@0.5:** 0.768 (accuracy at IoU=0.5).
- **mAP@0.5:0.95:** 0.446 overall (smoke: 0.519, fire: 0.373, person: 0.347).

System

Overview:

- Mobile app for real-time smoke & fire detection.
- **Frontend:** User login, live CCTV feed uploads.
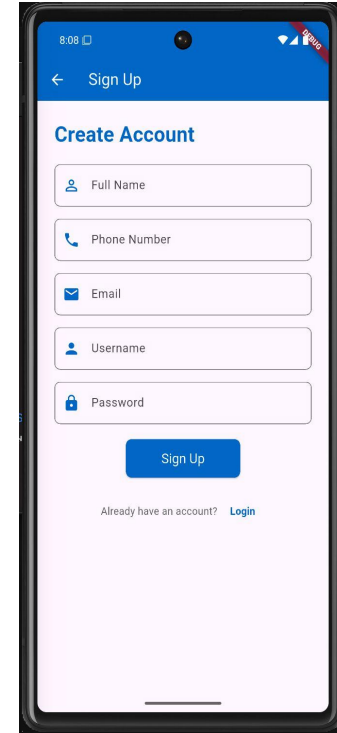- **Backend:** YOLOv11n model processes feeds.

Functionality:

- Detects fire and person in live streams.
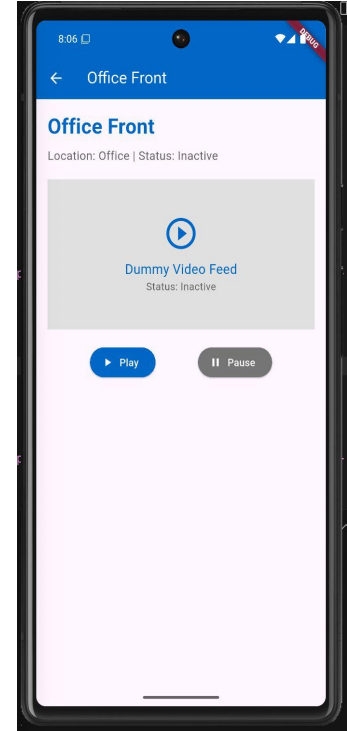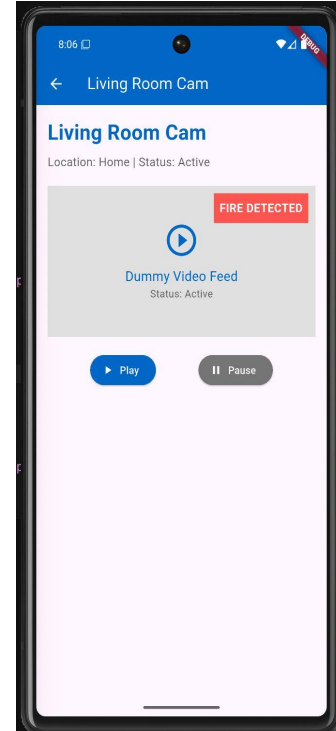- Sends alerts: App notifications.
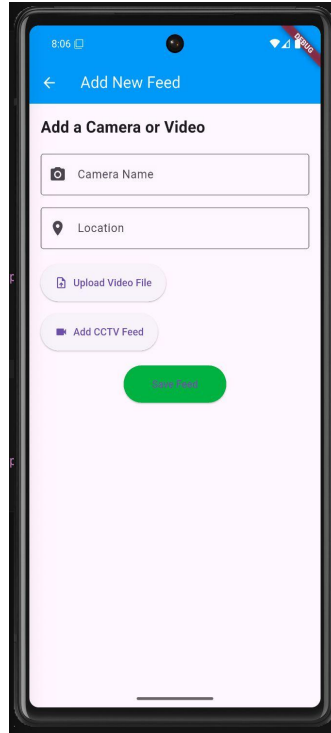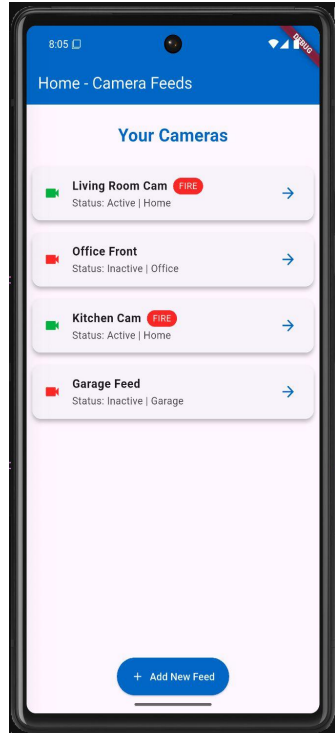
Tech Stack:

- **Frontend:** Flutter (Dart)
- **Backend:** Flask (Python)
- **Database:** MongoDB
- **AI/ML:**

Demo Link

YOLO11n

System

Model Results Comparision

Model Name	Precision	Recall	mAP@0.5	mAP@0.5:0.95	Latency
YOLOv8n	0.758	0.672	0.743	0.426	61 ms
RTMDet	0.762	0.685	0.754	0.435	57 ms
YOLOv11n	0.765	0.702	0.768	0.446	54.4 ms

Individual Contributions

Akshat Parmar: Fine-tuned RTMDet model and YOLOv11n for fire detection, focusing on hyperparameter optimization and training pipeline setup.

Tharun Harish: Developed mobile app, integrating real-time fire/person detection with YOLOv11n inference.

Vikranth Udandarao: Conducted literature review, analyzed related work for model research and prepared the report.

Vimal Subburaj: Prepared D-Fire and Human Dataset, handled data preprocessing, and evaluated model performance of YOLOv11n.

Thank You