



LENS

Low-light Environment Neural Surveillance

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Problem

- Strong correlation between criminal activity and dimly lit public spaces
- Need for intelligent devices to augment police efforts
 - Reduce need for active police presence
- Areas like parks, industrial complexes, private green spaces, etc. pose a problem for traditional surveillance mechanisms
 - CCTV only reactively identifies criminals
 - Blue light systems require active use

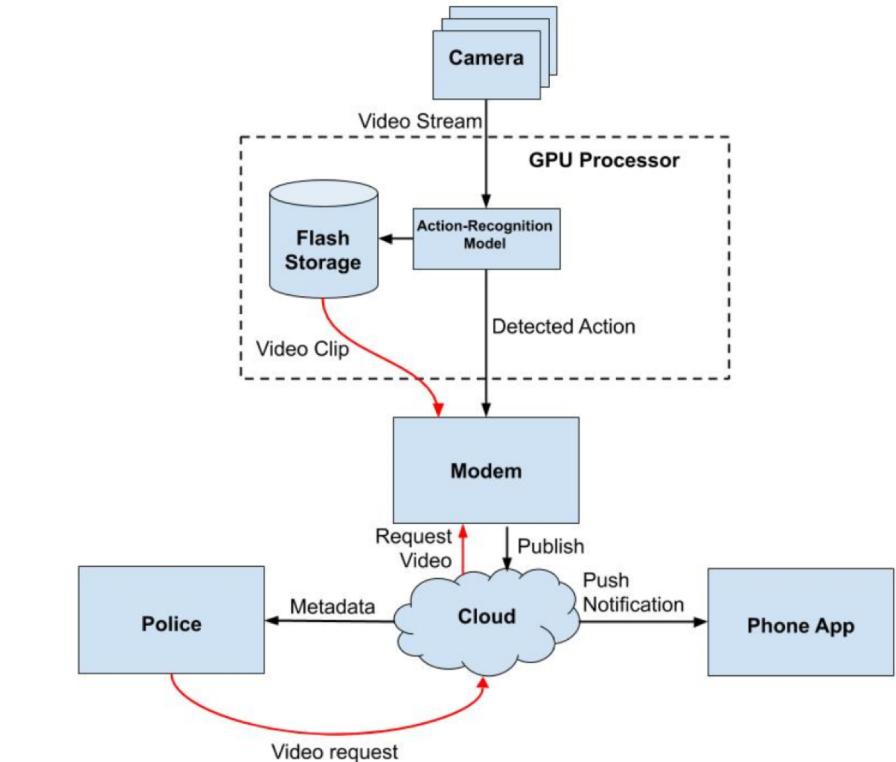


Our Solution

- Camera footage is analyzed locally by a computer vision action-recognition model
- Works in low light
- Footage does not need to be manually viewed
- Law Enforcement receive direct alerts to criminal activity in the area
- Passive solution does not require victims to engage the system
- Proactive solution, quicker response time

Approach

- Hardware
 - Camera
 - GPU
- Cloud
 - Databases
 - Serverless Computing
- Mobile App
- Computer Vision
 - Action recognition
 - Thresholding/postprocessing



Hardware

Compute Board

- NVIDIA Jetson TX2- \$300
 - CPU
 - ARM Cortex-A57 (quad-core) @ 2 GHz
 - NVIDIA Denver2 (dual-core) @ 2 GHz
 - GPU
 - 256-core Pascal @ 1.3 GHz
 - Video capabilities
 - 4Kp60, (3x) 4Kp30, (8x) 1080p30 Encoder
 - (2x) 4Kp60 Decoder
 - Network
 - 802.11a/b/g/n/ac 2×2 867Mbps
 - Bluetooth 4.1

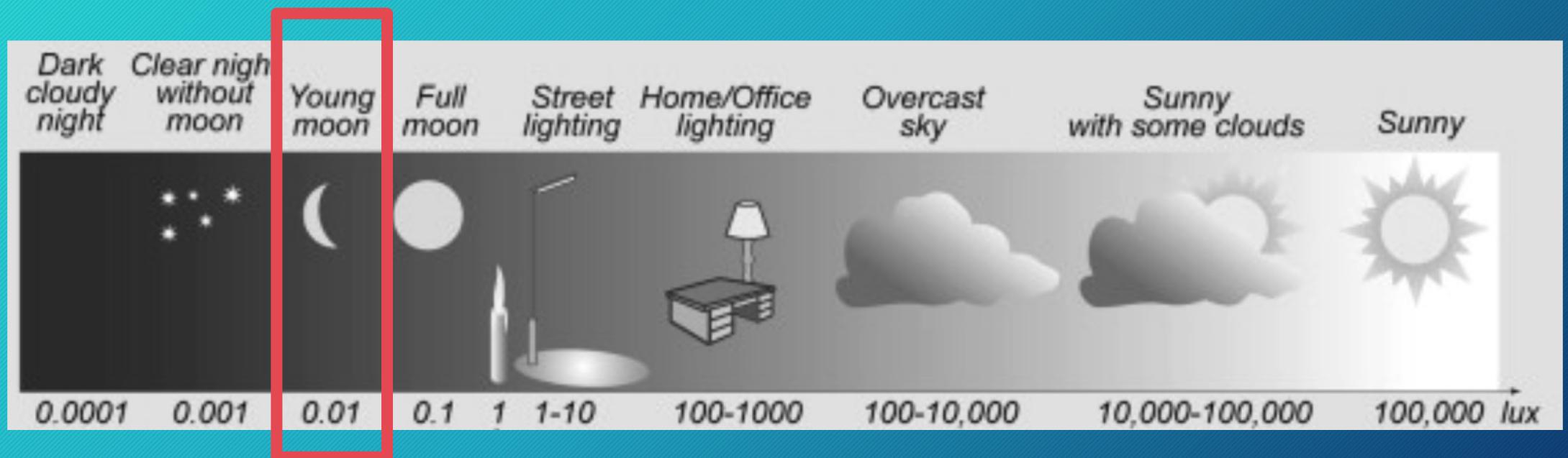


Low-Light Camera

- ELP Sony IMX322- \$70
 - Sensor
 - 1/2.9'' Sony IMX322 CMOS
 - Manual and auto image acquisition
 - Framerate
 - 1920x1080 @ 30fps
 - 1280x720 @ 60fps
 - Low-light capabilities
 - 42dB SNR
 - 86dB Dynamic Range
 - 0.01 lux



Lux



Camera Performance

Low Light Camera



Non-Low Light Camera



Cloud Architecture

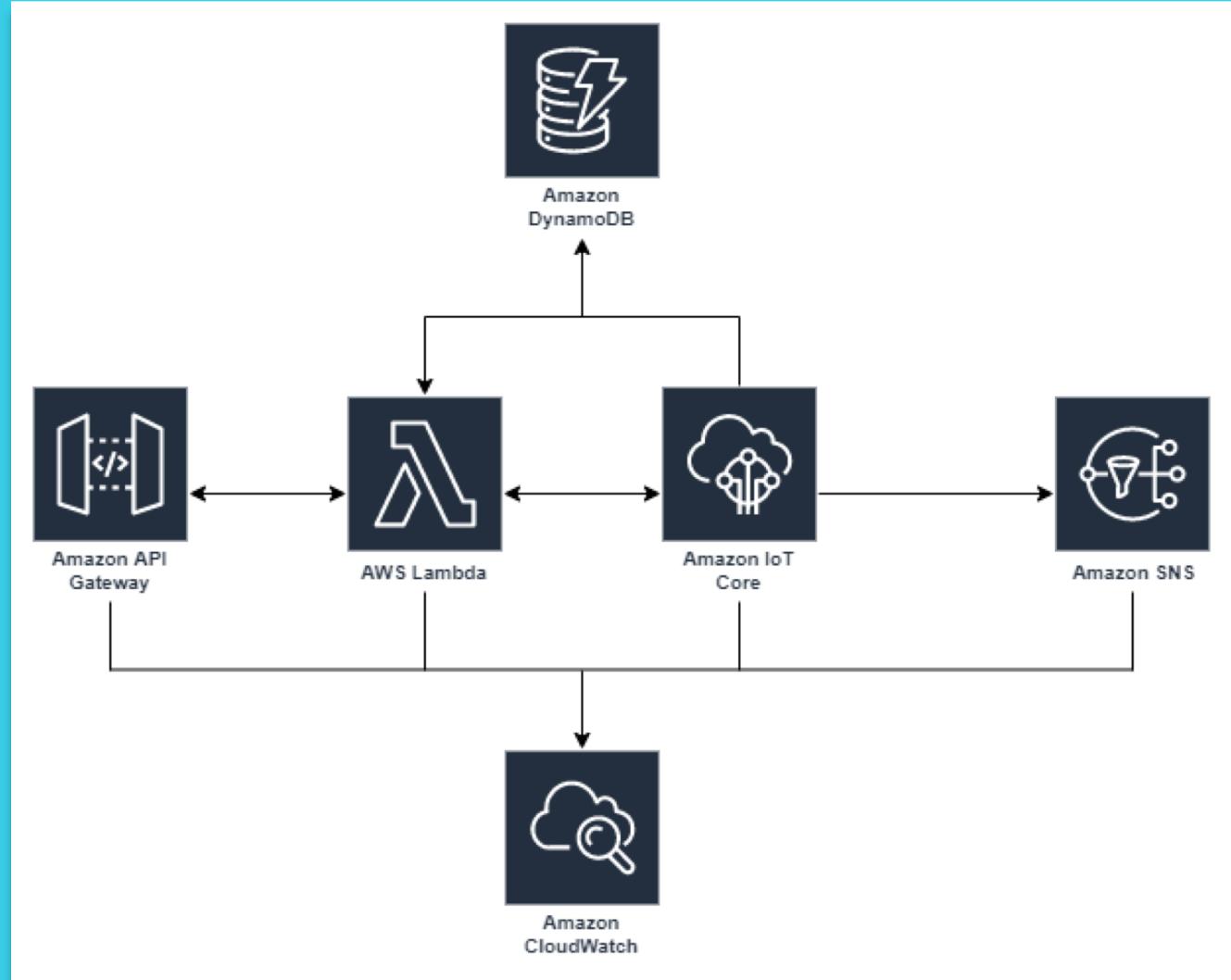
Device to Cloud

- Model passes positive crime predictions to a local parsing and processing layer
- Processing layer communicates crimes to cloud databases, and transmits requested videos to online storage
- Law Enforcement view recent crime detections in police portal application
- Citizens can opt-in to receive notifications when police determine a crime credible and dangerous



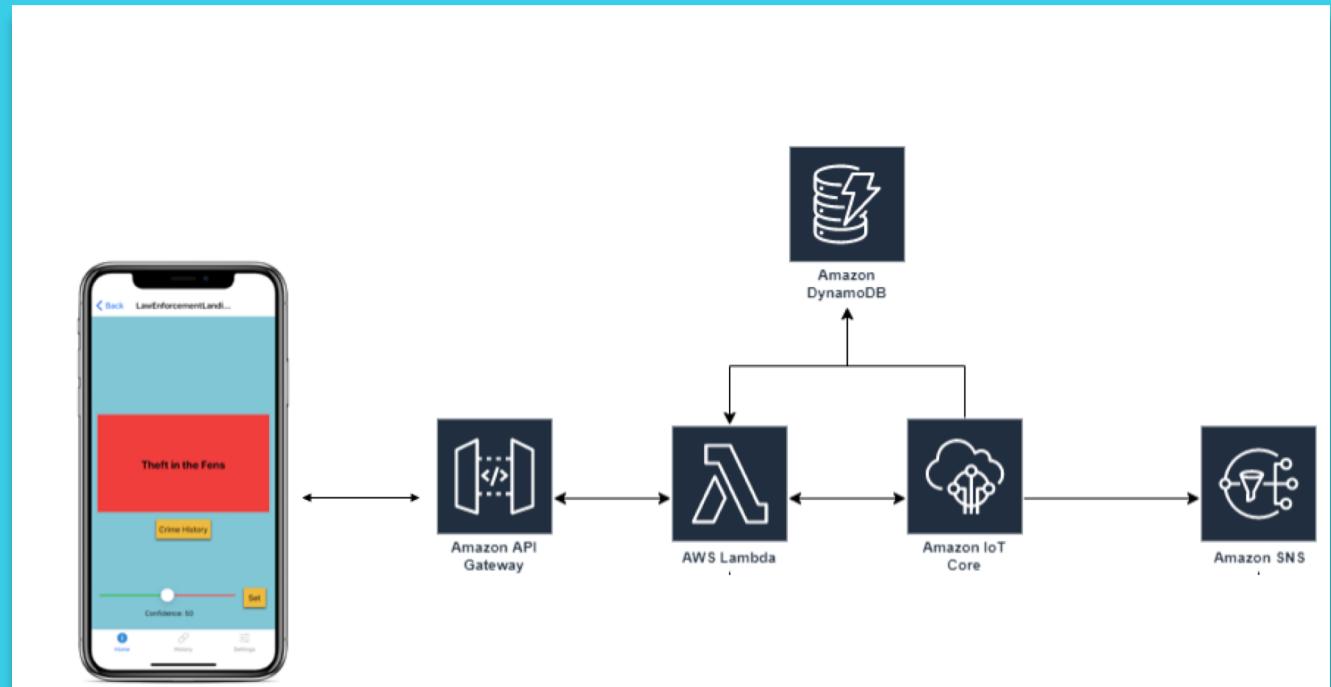
Amazon Web Services

- Camera connects via MQTT to the IoT core which handles security, and communicates information to DynamoDB and S3
- Apps connect via API Gateway, which provides access to the database
- Law enforcement portal triggers SNS to send text message



User Interface

- Cross Platform Mobile App
 - React Native
- Integrated with AWS backend
- Separate law enforcement and civilian apps
- Text notifications



HomeScreen



Low-Light Environment Neural
Surveillance

Police

Civilian



Home



History



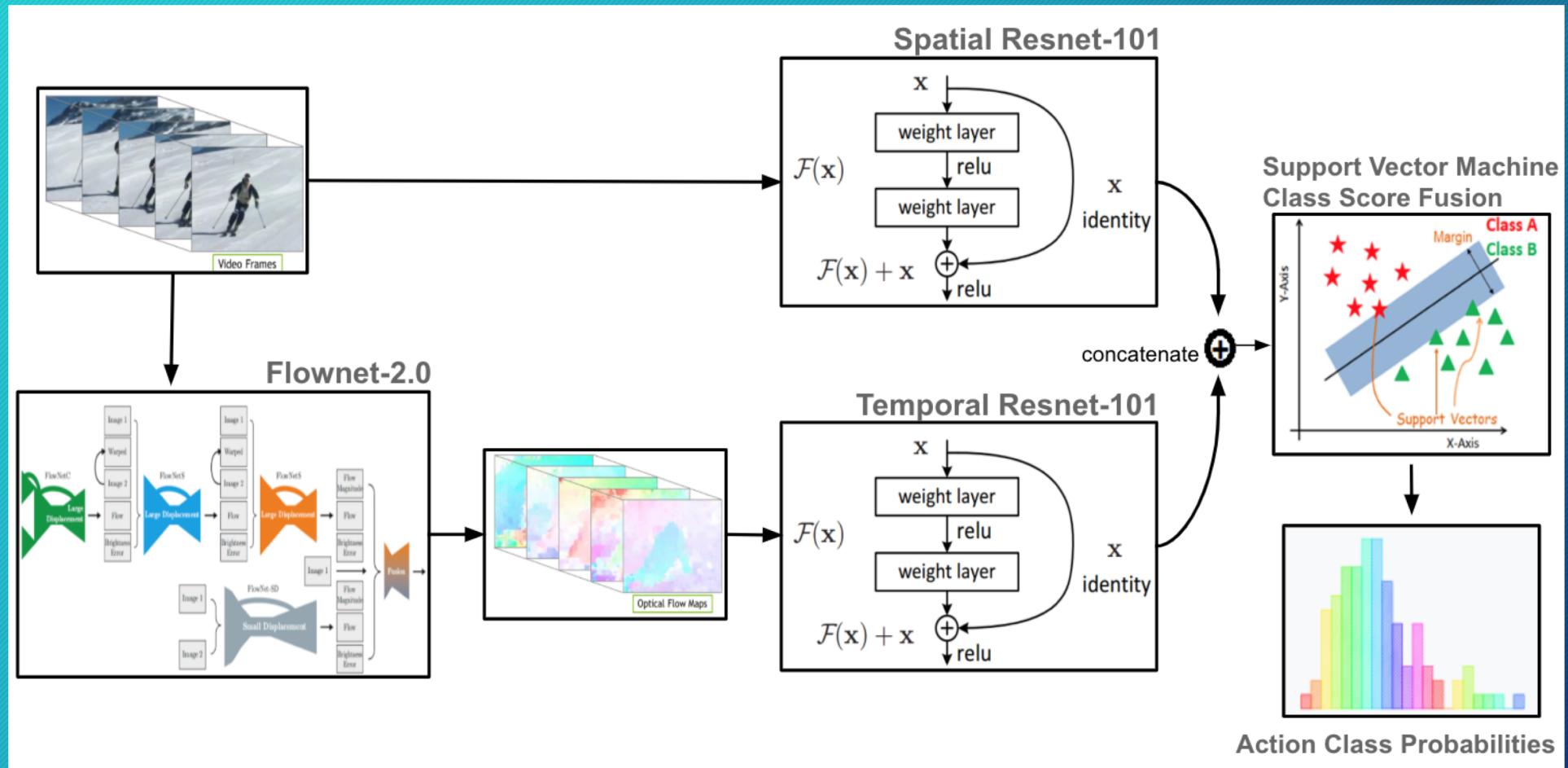
Settings

Computer Vision

Data Collection



Network Architecture

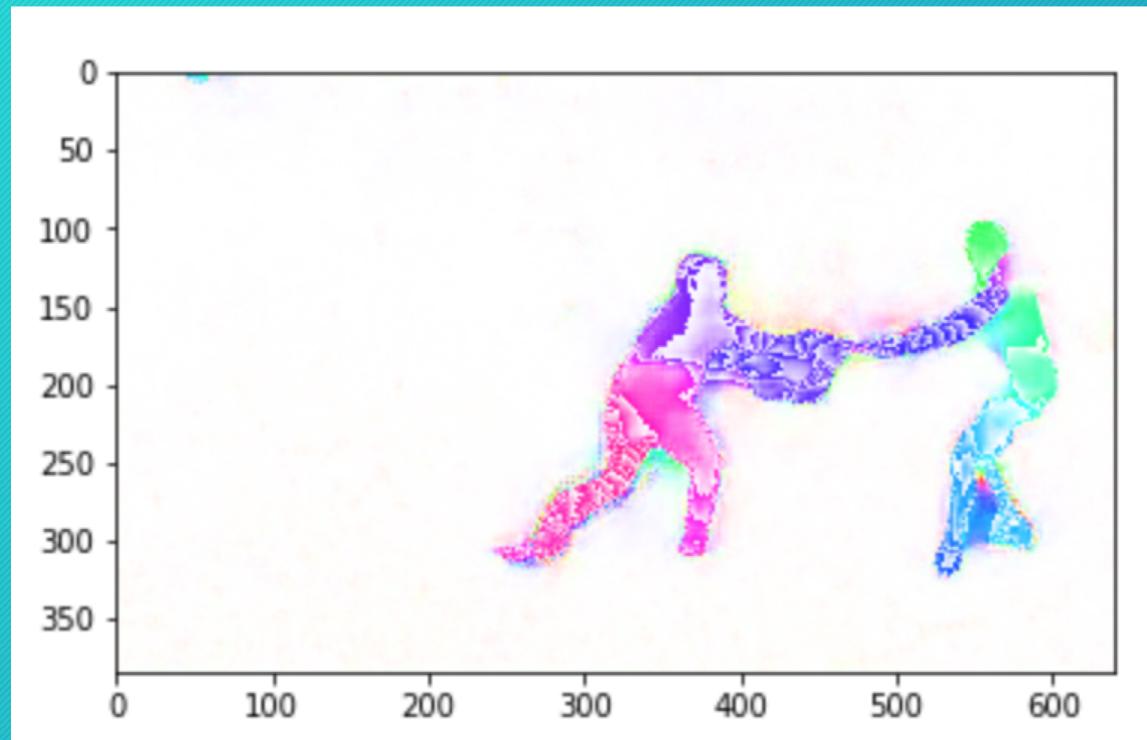


Optical Flow

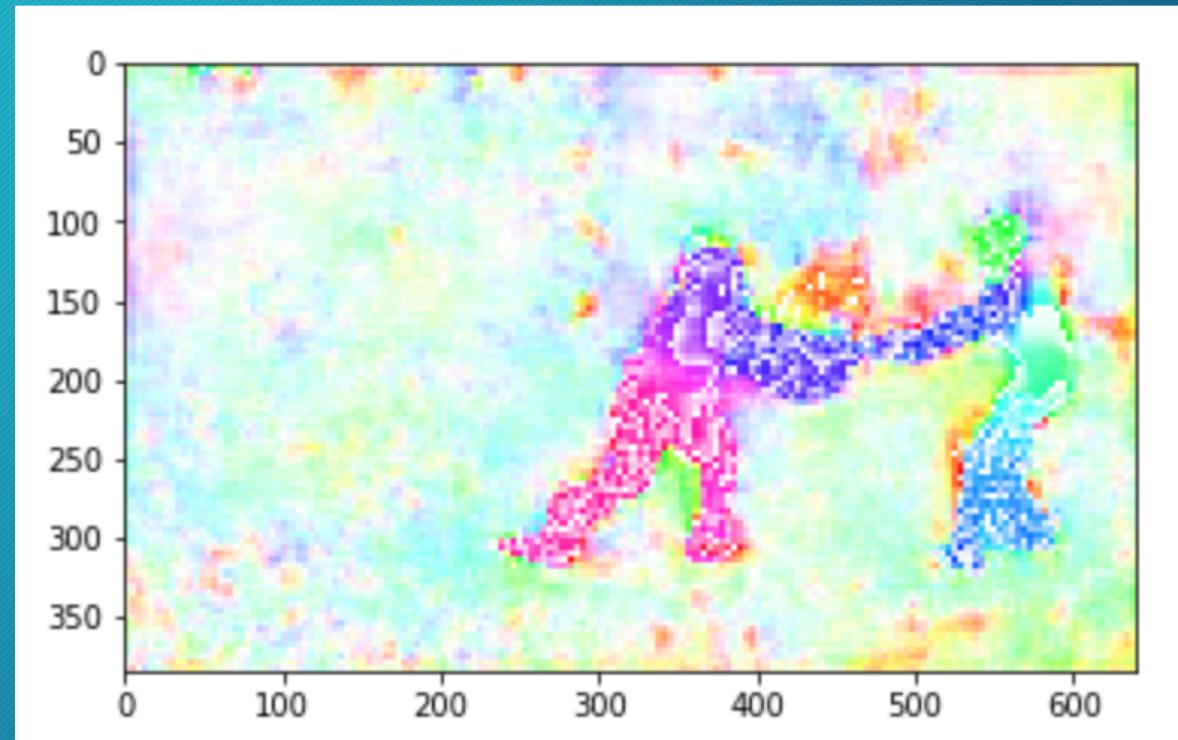
- Technique for recovering motion from images and video
- Required for proper action understanding
 - Actions cannot exist at a single instance in time
 - Allows understanding of movement over time



Optical Flow



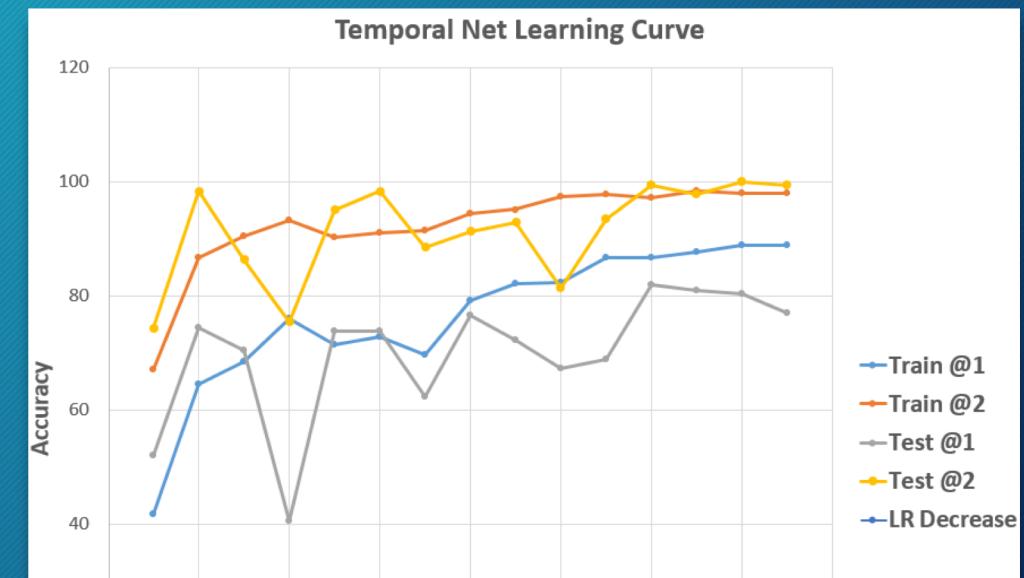
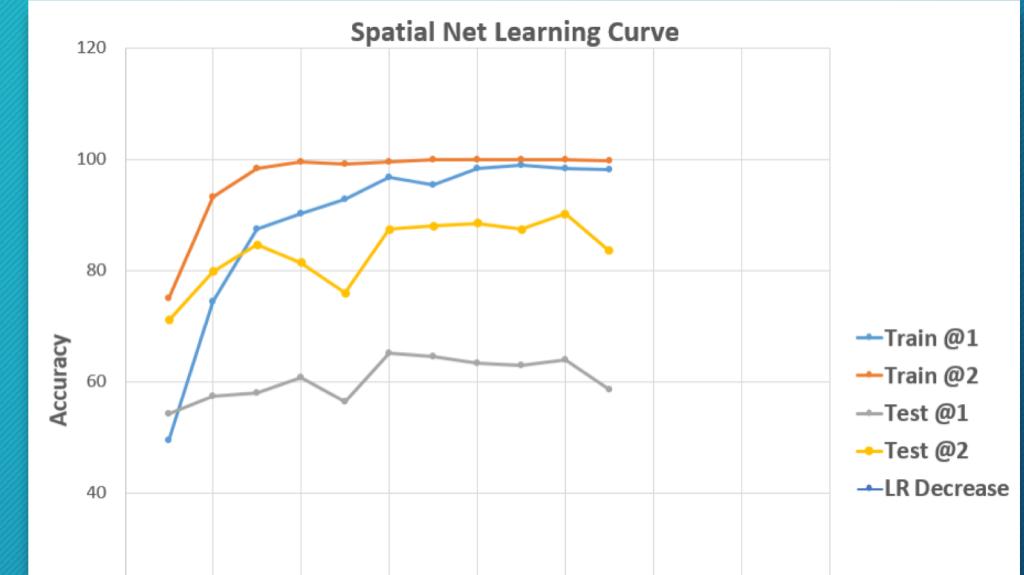
High Accuracy, Low Framerate



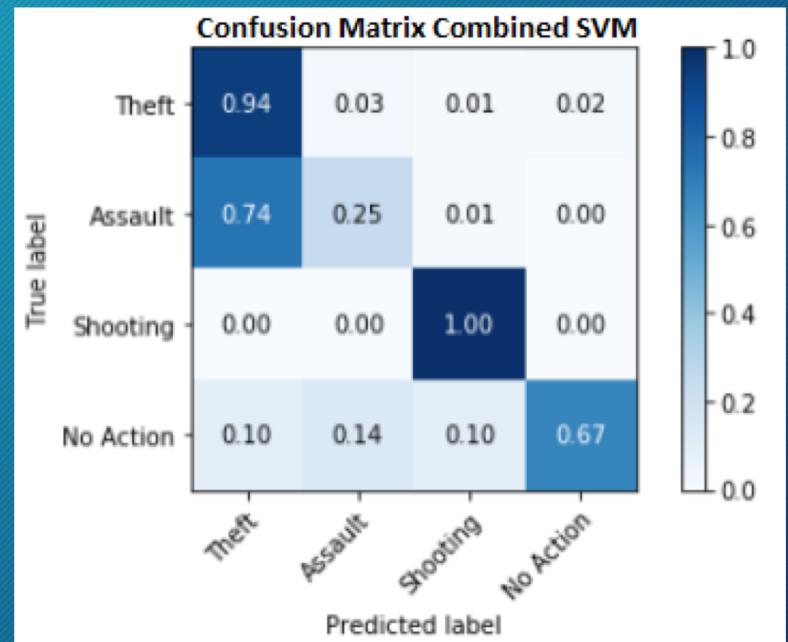
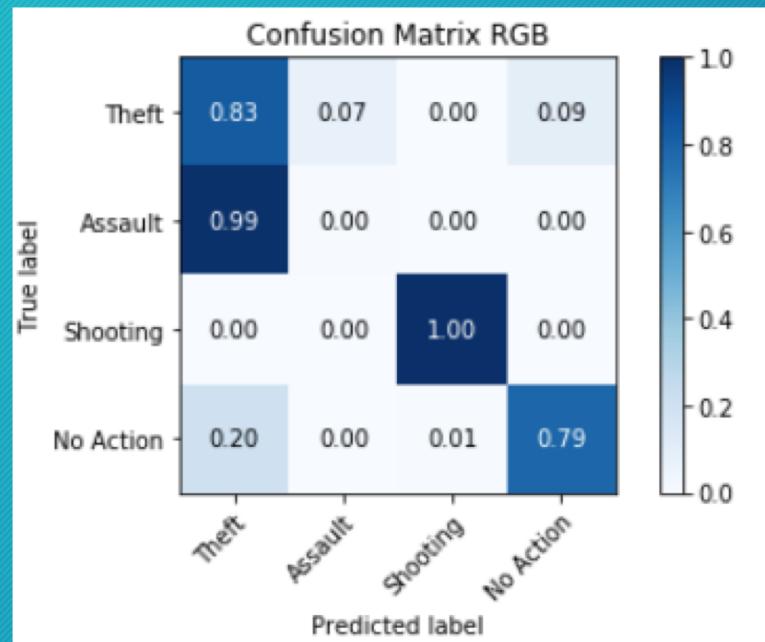
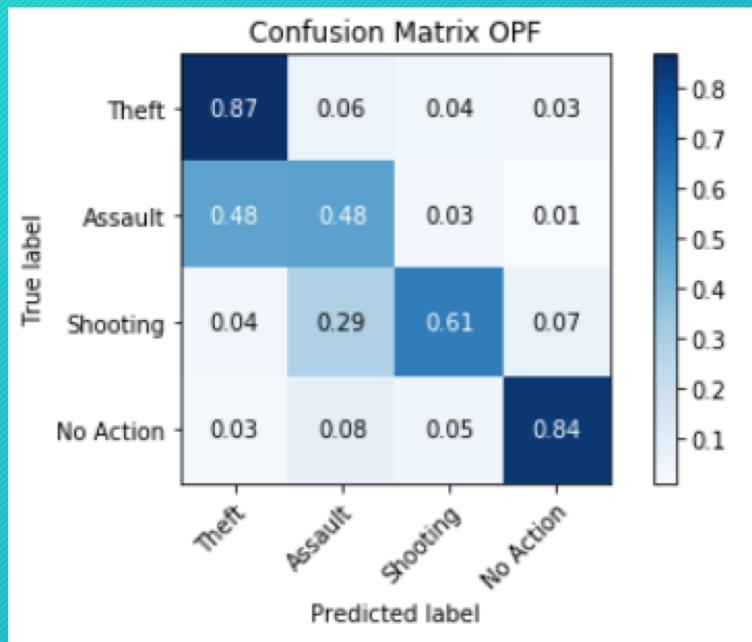
Low Accuracy, High Framerate

Training

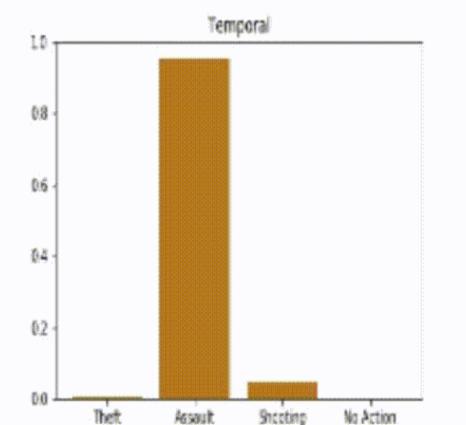
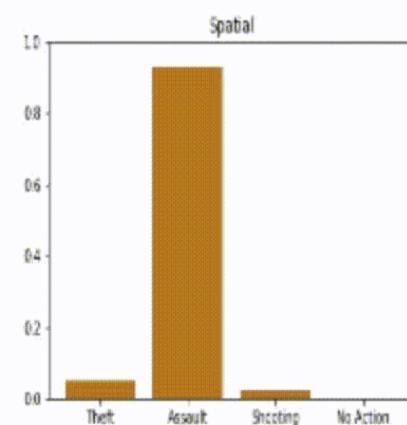
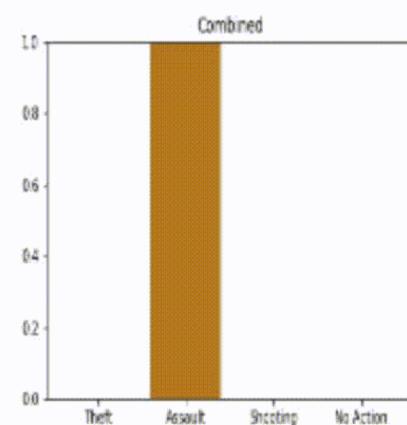
- Two-stream
 - Pretrained on ImageNet + UCF101
 - Fine-tuned on custom dataset
- Results
 - Spatial: 71% accuracy
 - Temporal: 87% accuracy
- Support Vector Machine (SVM)
 - Aggregate predictions from spatial and temporal predictions
 - Extremely long train time



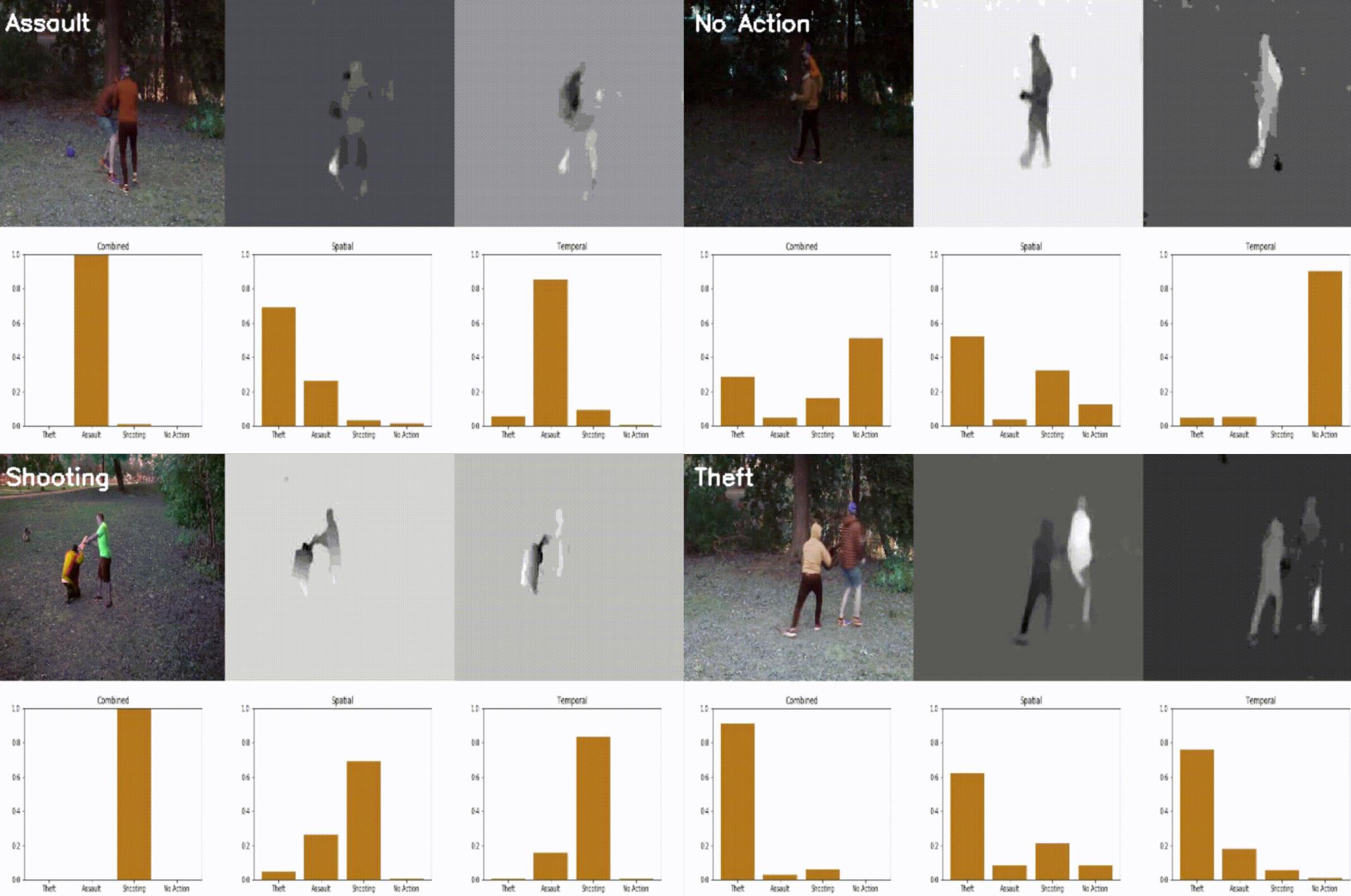
Results



Results

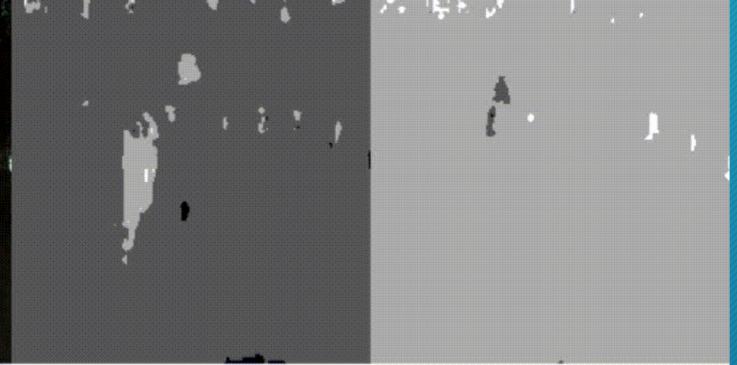
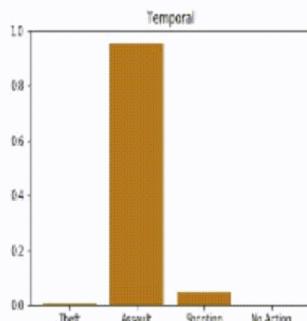
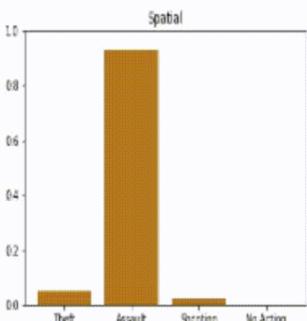
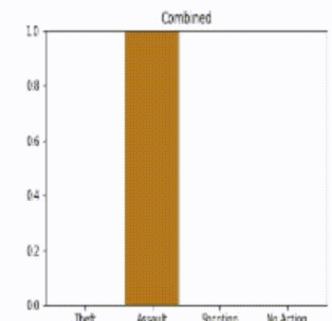


Light Environment

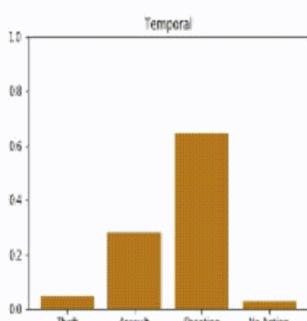
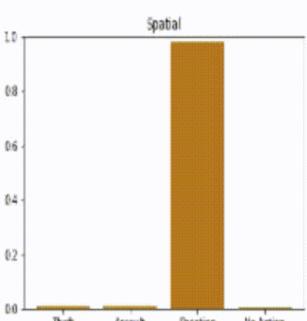
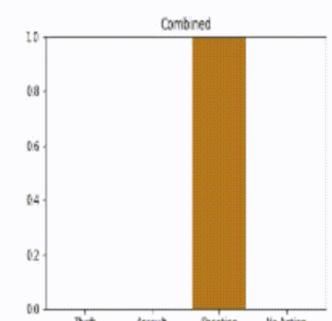


Dark Environment

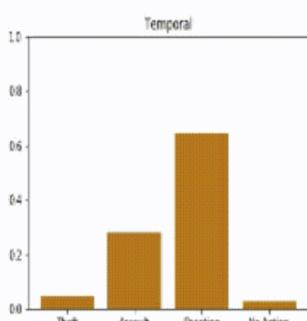
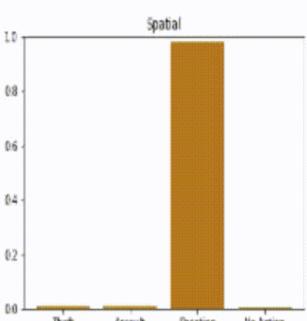
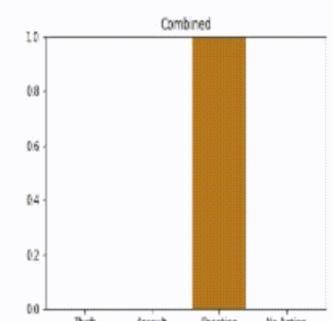
Assault



Shooting



Theft



Cost Benefit Analysis

Criteria	Traditional Security	LENS
Initial Cost	\$0	\$370 (per camera)
Monthly Cost	\$8,300 (\$12/hour)	\$1 (per camera)
5-Year Total	\$500,000	\$430
Attention	Divided	Undivided