Advanced Recognition Systems
Going from AFIS to ARS to Prevent & Solve More Crime
103rd Annual IAI International Forensic Educational Conference
Henry B. González Convention Center, San Antonio, Texas
31 July 2018 at 8:45am thru 9:30am
John Burt, Certified Latent Print Examiner and SME Trainer, NECAM ARS
John Dowden, Senior Product Manager, NECAM ARS
Greetings and Salutations

This workshop focuses upon the latest available biometric and video analytical technologies. Combined, the global market for biometrics and video analytics is estimated to be over $30 billion dollars. Integrated as a solution, these technologies primarily target the public safety and security markets. Together, these technologies can identify more people and recognize more patterns in order make more predictions to mitigate crime. As part of this workshop, NEC will explain and demonstrate the latest biometric and video analytic technologies and products that can be utilized to render advanced recognition systems.
More Greetings and Salutations

There are two primary spheres of foundational knowledge that support the latent print discipline: 1) science demonstrating the discriminating power of friction ridge impressions and 2) science demonstrating that trained analysts are capable of providing valid conclusions. While many analysts receive the knowledge portion during training, they often struggle articulating the concepts for the trier of fact:

1. Empirical Observations and Tacit Knowledge
2. Measuring the Discriminating Power of Fingerprints
3. Expert Performance

Advanced Recognition Systems
Agenda of Session

Overview of Biometrics and Video Analytics Technology

Attributes, Features and Benefits of Video Analytic Solution

Attributes, Features and Benefits of Video Analytic Solution

Video Analytic Solution Examples and Success Stories

Conclusion
What is at the core of our mission?

People. Patterns. Predictions.
People.

Our primary mission is to serve citizens and the people who protect them.

Whether keeping the public safe at home, supporting troops overseas, improving the experience of travelers, or providing the right identity at the right time, our Advanced Recognition Systems supply trusted intelligence to help build safer and brighter communities.
Patterns.

From fingerprint, facial to iris pattern recognition to arrangements of accessible data, sequences of critical information are everywhere — you just have to know where to look.

Our cutting-edge Advanced Recognition Systems can pinpoint valuable patterns for solving crime, strengthening national security, and identifying trends and efficiencies for tech-savvy businesses. All to help enable diverse missions and realize the possibilities.
Predictions.

Our **Advanced Recognition Systems** can transform the efficiency of your team.

Instead of simply gathering and reporting data, our technologies can **analyze intelligence to predict public safety threats**, alert agencies to emerging global concerns, pinpoint potential risks in high-traffic venues, and provide invaluable input to critical business decisions.
Learn More at www.necam.com/advancedrecognitionsystems

People. Patterns. Predictions.

Meet the new NEC Advanced Recognition Systems

Read Blog

Law Enforcement
Predictive identification systems that solve crimes and save lives

Federal Government
Enabling the safety, security and economic interests of the United States

Critical Infrastructure
Highly accurate recognition technologies that eliminate threats in high-traffic spaces

Interested In Our Complete Portfolio of Identity Matching Solutions?
Biometrics and Video Analytics are Predictive (and Reactive) Technologies
Biometric Technology Overview

- **Biometric** is used for automatic personal recognition and manual based on biological or behavioral characteristics
  - Identification
  - Authentication/Verification
  - Investigation
  - Different Modalities
  - Multi-Modal and Fusion
Examples of Multi-Modal Biometric Systems

FBI CJIS Next Generation Identification

- Friction Ridge:
  - Tenprint ID and Palmprint
  - Latent Investigation
- Facial Recognition
- Iris Recognition POC Pilot
- DNA ID & Investigation (CODIS)

DHS OBIM IDENT (or HART)

- Friction Ridge:
  - Tenprint ID
  - Latent Investigation
- Facial Recognition
- Iris Recognition Option
Los Angeles County SD Upgraded from an AFIS to a MBIS

Interfaces

County WAN

Los Angeles County Sheriff Department – Primary Site
Los Angeles County Sheriff Department – COOP Site

Cogent Mobile ID System
County Livescans
LAPM
CWS
AJIS

Integrated System Monitor (Web Client)
Integrated Biometric Workstation (Tenprint x 9)
Integrated Biometric Workstation (Latent x 65)
ANSI/NIST Archive (Web Client)

Local Agency Server

SAN Storage System

VMware ESXi
DM/MM
iESB

Active Data Synchronization

NEC AIM Matching System
Oracle 11g (RAC)
SAN Storage System

VMware ESXi
DM/MM
iESB

CLETs

FBI
CalDOJ
WIN

ADVANCED RECOGNITION SYSTEMS

NEC NOC Operation – Remote Management Services
Overall Biometrics Workflow

**Enrollment**

Present Biometric → Capture → Process → Store

No Match

**Verification**

Present Biometric → Capture → Process → Compare

Match
Multi-Modal Livescan Stations at Remotes Sites
Livescan Multi-Modal Creation, Data Entry and Biometric Image Capture

Retention Code: Y
Name: DOE, JOHN E
Place of Birth: CA
Date of Birth: 19850521
Sex: M
Race: W
Height: 600
Weight: 200
Color Eyes: BLU

Advanced Recognition Systems

Orchestrating a brighter world
Livescan Case Review, Printing and Submission to MBIS
Centralized Management of the Multiple Biometric Systems & Equipment
Multi-Modal Workstations at the ID Bureaus and Crime Labs
MBIS Case Entry, Submission for Search and Case Review
Browse: Find Records based upon IDs and Meta-Data

Job Queue: Listing of Jobs including Per Type/System/Person

Tenprint: Create New Person Records

QC Edit: Review and Edit Person Records

Latent: Create and Manage Latent Cases including Evidence & More

Verify: Review and Compare Search Results
Dedicated Facial Investigative Workstations for Detectives & Examiners
Benefit of Facial Recognition to Generate Tips & Leads for Investigation
Transitioning from Biometrics to Video Analysis
Why Video Analytics? Because there are many cameras out there!

- Over 500 Million Professional Video Surveillance Cameras Worldwide
- Over 15 Million Home Video Surveillance Cameras in the USA
- Over 2.4 Billion Smartphones Worldwide
- Over 3 Million Police Body Cameras Worldwide

Number of Cameras Across the World Will Reach 45 Billion By 2022
Video Analytics or Video Content Analysis (VAC) Technology

Video Analytics or Video Content Analysis involves autonomous understanding of events (in video) in order to reduce the burden by removing the uninformative data for subsequent analysis and to augment the given task for monitoring, logging and action:

- Identification, Detection & Monitoring
- Alert Notification
- Meta Data Extraction & Collection
## Video Analytic Technology Modalities

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
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<tbody>
<tr>
<td>Dynamic Masking</td>
<td>Blocking a part of the video signal based on the signal itself, for example because of privacy concerns.</td>
</tr>
<tr>
<td>Flame and Smoke Detection</td>
<td>IP cameras with intelligent video surveillance technology can be used to detect flame and smoke in 15–20 seconds or even less because of the built-in DSP chip. The chip processes algorithms that analyzes the videos captured for flame and smoke characteristics such as color chrominance, flickering ratio, shape, pattern and moving direction.</td>
</tr>
<tr>
<td>Egomotion Estimation</td>
<td>Egomotion estimation is used to determine the location of a camera by analyzing its output signal.</td>
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<tr>
<td>Motion Detection</td>
<td>Motion detection is used to determine the presence of relevant motion in the observed scene.</td>
</tr>
<tr>
<td>Shape Recognition</td>
<td>Shape recognition is used to recognize shapes in the input video, for example circles or squares. This functionality is typically used in more advanced functionalities such as object detection.</td>
</tr>
<tr>
<td>Function</td>
<td>Description</td>
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<tr>
<td><strong>Object Detection</strong></td>
<td>Object detection is used to determine the presence of a type of object or entity, for example a person or car. Other examples include fire and smoke detection.</td>
</tr>
<tr>
<td><strong>Multi-Mode Recognition</strong></td>
<td><strong>Face Recognition and Automatic License or Number Plate Recognition</strong> are used to recognize, and therefore possibly identify, persons or cars.</td>
</tr>
<tr>
<td><strong>Style Detection</strong></td>
<td>Style detection is used in settings where the video signal has been produced, for example for TV broadcast. Style detection detects style of production process.</td>
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<tr>
<td><strong>Tamper Detection</strong></td>
<td>Tamper detection is used to determine whether the camera or output signal is tampered with.</td>
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<tr>
<td><strong>Geo-Spatial Tagging</strong></td>
<td>Process of adding geographical identification to video. This data usually consists of latitude and longitude coordinates, though they can also include altitude, bearing, distance, accuracy data, and place names, and perhaps a time stamp</td>
</tr>
<tr>
<td><strong>Video Tracking</strong></td>
<td>Video tracking is used to determine the location of persons or objects in the video signal, possibly with regard to an external reference grid.</td>
</tr>
<tr>
<td><strong>Video Error Level Analysis</strong></td>
<td>Video scene content tamper analysis including video content cropping, addition</td>
</tr>
</tbody>
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Use Cases of Video Analytics for Public Safety

- Face recognition
- Tracking
- Lost people
- Suspicious person
- Crowd detection
- Left object detection
- Climbing over the wall
Use Case Environments for Video Analytics

- **Crime Prevention Solution**
  - Black List Matching
  - Suspicious Behavior Detection

- **Accidents Prevention Solution**
  - Falling-Down Sign
  - Vehicles Intrusion Monitoring Facilities

- **Border Identification Solution**
  - Illegal Entry Detection
  - Congestion Detection

- **Urban**
- **Airport/Harbor**
- **Railway**
- **Police**
- **Stadium/Hotel**
Identification and Detection

Positive Identification
- Facial Identification

Objects Identification
- Person, Vehicles, License Plates…
Crowd Counting, Demographics and Estimation

- Demographics
  - Age
  - Gender

- Facial Expressions

- Clothing type/color

- Tracking

- Wearables
  - Hats
  - Glasses
Additional Crowd Analytics

Region Based Counting

Person Density Heat Map
Motion Pattern Analysis

**Individual Object Tracking**

**Direction Flow**

- Crowd at Road 1 moving toward Road 2
- Crowd at Road 2 moving toward Road 3
- Crowd at Road 3 moving toward Finish Line

Advanced Recognition Systems
Behavior Analysis
Learn More About Video Analytics => Go Read Recent NIST Reports

NISTIR 8173: Face In Video Evaluation - Non-Cooperative Subjects

NISTIR 8164: Workshop on Video Analytics in Public Safety
Face in Video Evaluation (FIVE *1) performed by NIST*2

Continuation of Facial Recognition Testing by NIST Since 1993: FERET, MBE, MBGC and FRVT

- Major global vendors participate in the evaluation
- Evaluation is done through blind testing and is rigorous and fair.
- Tests conducted under various environments meet requirements in actual implementations.

Continued technological enhancement based on market requirements gained through experience in the field

*1 NIST FIVE Results on NIST website: https://www.nist.gov/programs-projects/face-video-evaluation-five
*2 US National Institute of Standards and Technology
Evaluation Ex1 : Passenger Gate

Recognition of individuals walking past without acknowledging the camera
Application for entry-exit management at an airport passenger gate

- Matching of the individual approaching, against registered faces in the database
  - Galleries: 480 (number of passengers on an aircraft)
  - Dataset: 248 Videos (1 individual/ video)
  - Evaluation for rank 1 recognition

- Face captured close to the camera, one by one

Ideal for Video Face Recognition

※“DATASET U: PASSENGER GATE” in the NIST Report
※Images processed for privacy

Advanced Recognition Systems
https://www.nist.gov/programs-projects/face-video-evaluation-five

Orchestrating a brighter world
Evaluation Ex2 : Sports Arena

Detection of suspicious individuals at an indoor stadium
Difficult environment with subjects far from the camera with varying face angles

- Matching of all faces captured by the camera against registered faces in the database
  - Galleries : 480
  - Matching against videos (total 133 hours 15 minutes)
  - Evaluation for hit rate (threshold set by NIST)

- Far from camera (low res), multiple subjects, varying face angles
  Difficult environment for Video Face Recognition

※“DATASET P: SPORTS ARENA” in the NIST Report

*Images processed for privacy
Direction of Technical Advancement

Realize a system to enable instant detection/identification/tracking of suspicious individuals in a crowd for a safer society

Identify individuals in an area with millions of people
Identify suspicious behaviors and track the movement

Early detection of suspects and suspicious individuals to enable preventative measures
Summary of Video Analytics

Detection, Identification & Converge

Surveillance & Watchlist Monitoring

Capture | Encoding | Compression | Transmission/Communications | Broadcasting/Distribution | Alerting | Triage | Forensics | Data Storage and Management

Advanced Recognition Systems
Advanced Recognition Systems: Biometrics and Video Analytics

Attributes, Features & Benefits of Video Analytical Solution
Different Vendors Provide Different Types of Video Analytics Solutions

Video Camera Vendors Can Often Provide VA Technologies at the Edge:
- Features: Motion Detection (MD), Autotracking, Tampering Notifications and Audio Detection
- Benefits: Enhancing Video Surveillance Efficiency

Video Management System Vendors Can Perform VATs and More at the Center:
- Features: MD and LPR, Multi-Viewing, Edge PTZ Control, Video Archival and Storage
- Benefits: Providing Command, Control, Communications, Computers, and Intelligence (C4I)

ICT Vendors Can Provide Digital Evidence Management Systems (DEMS)
- Features: Integrate Video Streams in Real Time from Different Cameras with Metadata Collection and Archiving
- Benefit: Maintains Digital Evidence, Data Integrity and Authenticity for Court Presentation

Other Vendors Can Provide Digital Criminal Analysis Systems (DCAS)
- Features: Similar to DEMS But More VCA and Metadata Extraction for Post-Incident Investigation
- Benefits: Solving Crime through Intelligence-Led Policing ~ Just Like They Do on CSI, NCIS, and other TV Shows

Or Preceding Vendors and System Integrators Can Provide All of the Above:
- Integration of Above Systems as well as Data Analytics for Unified Solution to Predict, Solve and Prevent

Advanced Recognition Systems
Example of a Video Analytics Solution for DCAS
Digital Criminal Analysis Features and Benefits

Service Oriented Architecture for new digital media ecosystem:
- Citywide surveillance can produce massive amount of media
- Images from several credential databases (Mugshots, passport, DMV, national ID…)
- Images and video from security events
- Exponential growth of Body Worn cameras/video
- Social media databases are growing exponentially…

Provides key capabilities to exploit this new digital media ecosystem
- Provides secure digital asset management and media analytics portal for agencies
- Real-time Monitoring, Threat Assessment & Escalation
- Post event investigation, intelligence, & analysis
- Advanced analytics, planning, and forecasting
Like Kindergarten, Video Analytics Can Answer the Big Questions

- **Who:** People Detection and Identification
- **What:** Object, Activity, Event, Behavior and Relationships
- **Where:** Frame Space, 3D Space, and World Map Space
- **When:** Time and Date
- **Meta-Data:** Little Details of Interest
Video Analytics Workflow

1. Sensing
2. Monitoring
3. Assessing
4. React
5. Respond and Act
User Interface for Display, Alert Notification and MetaData Results

Real-time Monitoring

People Count

Crowd Estimation

Demographics
Challenges of Video Analytics for BWC Devices and Systems

- The Good: Compact, HD Capture, Broad FOV and Shift-Half of DVR Recording
- The Bad and the Ugly: Not Full or Enhanced HD and Possibly Not Real Time Streaming
One Caution About Deploying A Video Analytics Solution: Privacy!

GWU/P&TC: The Perpetual Line-UP

DOJ/BJA: FR Policy Template
Advanced Recognition Systems: Biometrics and Video Analytics

Video Analytic Solution Examples and Success Stories
Pennsylvania Justice Network (JNET): Public Safety & Criminal Justice Portal

Enterprise Portal for LE Agencies:
- SOA, Web Services & XML Data Format
- Global Reference Architecture
- National Information Exchange Model
- Used by Local, State & Federal Agencies

40 Different Applications:
- Classic Multiple Name and Record Checks against Number of Databases
- PaJNET Photo Database:
  - 250 Capture Locations & 38,000 Web Users
  - Mugshot and FR Searches for Investigation:
    - Classic Mugshot Line-Ups and For Wanted Posters
    - Search Crime Photos & Video for Tip & Lead Generation
South Wales Police “Pilot” in United Kingdom: Mobile Video Analytics

Solution:
- Police Force Vans Equipped with HD Cams
- Search against 500,000 Mugshots
- Rolling Command Posts with Mobile Alerts
- Real Time Surveillance (RTS)
- Watch List Monitoring (WLM) for Warrants
- Crime Scene Investigation (CSI)
- Six Month Pilot Plus

Results:
- Additional Security for Public Events
- 191 suspects identified, with 12 arrests, 50 charges and 8 prison sentences
- “Faster and more accurately identify persons of interest!” per ACC Lewis
Facial Recognition deployed In All Major Cities Across Georgia in Asia

Solution:
- Over 400 IP Surveillance HDTV Cameras
  Plan to Grow to 10,000 Cameras
- 500 TB of Video Management System
  Plan to Grow to 10 of VMS Storage
- Facial Recognition for ID, RTS & WLM
- Supplemental License Plate Recognition
- 24x7 Network Operating Centers

Results:
- Proactive Crime Prevention
- Efficient Criminal Investigations
- "Safe City, Safe Region, Safe Country"
Solution:
- 24x7 Tigre Operations Center
- 200,000 Video Cameras & VMS
- Citizen Collaboration for Security
- VA Modes & Technology: Real Time Surveillance, Face Recognition, LPR, Behavior Detection & More

Results:
- 400 VA Monthly Legal Inquiries with 35% Increase in Crime Solving
- Crime Deterrence Effect from RTS
- Car Theft Rates Decreased by
Advanced Recognition Systems: Biometrics and Video Analytics

Conclusion

Summary Takeaways
Questions and Answers
Invitation to Exhibit and Reception
Grand Summary of Biometrics & Video Analytics

Biometrics: Capture, Process & Match

Video Analytics: Detect, Identify & Converge
There Are Many, Many Companies Involved with Video Analytics
People. Patterns. Predictions.

Meet the new NEC Advanced Recognition Systems

Law Enforcement
Predictive identification systems that solve crimes and save lives

Federal Government
Enabling the safety, security and economic interests of the United States

Critical Infrastructure
Highly accurate recognition technologies that eliminate threats in high-traffic spaces

Interested In Our Complete Portfolio of Identity Matching Solutions?
History of NEC’s Face Recognition Technology

1963 Start character recognition technology R&D
1989 Start face recognition R&D
Application of pattern recognition technology established through character recognition R&D
2002 Commercialize face recognition SDK “NeoFace”
2009-2013 Rank No.1 in NIST*1 Evaluation

3 consecutive wins in Still Image Matching
2009(MBGC*2), 2010(MBE*3), 2013(FRVT*4)

2017 Newly rank No.1 in Video Face Recognition Evaluation
NIST Face in Video Evaluation (FIVE*5)

Evaluation under various environmental conditions
Difference from Still Image Matching

Video Face Recognition is far more difficult

- High Speed (real time)
- Simultaneous recognition
- Distance from camera (low resolution)
- Various face angles
- Various lighting

Still Image
Cooperative

Video
Cooperative
Non-Cooperative
Growing Development of Facial-Video Recognition Technology

Wider Application and Enhanced Convenience.

- Wide Application
- Enhanced Convenience

- Video
  - Face Recognition
  - Non-Cooperative
  - Robustness
    - Lighting
    - Angle
    - Low Res
  - Video Analysis
    - Multiple Video
    - Quick Detection of Individuals

- Video
  - High Speed
  - Real time
  - Simultaneous

- Still Image
  - Cooperative
  - Identification or Investigation

- Existing Application

Level of Difficulty
**NEC’s Advanced Technologies for Video Face Recognition**

**Enhanced Robustness Against Partial Occlusion**
Find features of the face even in crowded environment when face is partially occluded

- Crowded Environment (Partial Occlusion)

**Enhanced Deep Learning**
Enable face comparison and matching with angled or low resolution (captured at a distance from a camera) images

- Change in Angel
- Far from Camera (Low Resolution)
Results of the Video Face Recognition Evaluation by NIST (US National Institute of Standards and Technology)

Face In Video Evaluation (FIVE)
Face Recognition of Non-Cooperative Subjects

https://www.nist.gov/programs-projects/face-video-evaluation-five

113 Pages
Face Recognition Technology Evaluation by NIST

Objective and fair evaluation of leading technology providers

- Conducted benchmark evaluation for the past 20 years
- Participated by leading technology providers, academia and research institutes from around the world
- Evaluation is done through blind testing and is rigorous and fair
- Identification of various subjects (sex, age, race)
- NEC participation since 2009
Overview of Face In Video Evaluation (FIVE)

Benchmark evaluation of video face recognition
Evaluation of recognition of non-cooperative subjects

- Start evaluation in **February 2015**. Final report issued in **March 2017**
- 16 leading technology provider took part. Sponsored by Department of Homeland Security (DHS)
- Application for **Access Control** and **Detection of suspicious individuals**
- Tested under various conditions (dataset, index, camera location, etc.)

**Evaluation Ex1 : Passenger Gate**
Entry-exit management at an airport passenger gate

**Evaluation Ex2 : Sports Arena**
Detection of suspicious individuals at an indoor stadium

*Images processed for privacy

https://www.nist.gov/programs-projects/face-video-evaluation-five
Participants in Face In Video Evaluation (FIVE)

**Competition among world leading technology providers**

- Enterprise, academia, research institutes can take part
- 16 teams participated (all enterprises)
- Participants by countries; US 5, Japan 3, Others 1 each
- Participant name and results written in the report

<table>
<thead>
<tr>
<th>Name</th>
<th>Country</th>
<th>Participation in FRVT2013</th>
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<tr>
<td>Vigilant Solutions</td>
<td>USA</td>
<td></td>
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<td>Vapplica</td>
<td>USA</td>
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<td>3M Cogent (Gemalto)</td>
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<td>CyberExtruder</td>
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<td>Rank One Computing</td>
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- Face captured close to the camera, one by one
  Ideal for Video Face Recognition

※“DATASET U: PASSENGER GATE” in the NIST Report
https://www.nist.gov/programs-projects/face-video-evaluation-five
*Images processed for privacy
Error Rate less than ¼ of the second place participant
High Accuracy in “recognition of individuals walking past without acknowledging the camera”

Results shown from the Face In Video Evaluation (FIVE) do not constitute endorsement of any particular product by the U.S. Government. https://www.nist.gov/programs-projects/face-video-evaluation-five
Evaluation Ex2 : Sports Arena

Detection of suspicious individuals at an indoor stadium
Difficult environment with subjects far from the camera with varying face angles

- Matching of all faces captured by the camera against registered faces in the database
  - Galleries : 480
  - Matching against videos (total 133 hours 15 minutes)
  - Evaluation for hit rate (threshold set by NIST)

- Far from camera (low res), multiple subjects, varying face angles
Difficult environment for Video Face Recognition

※“DATASET P: SPORTS ARENA” in the NIST Report

※Images processed for privacy
Evaluation Result Ex2: Sports Arena

Prove robustness against low resolution and angled face data critical for surveillance application

Error rate half that of the second place error rate

High Watchlist Detection Rate
NEC 85.4%, 2nd place 61.4%

Comment by NIST in the report
“Only one (NEC) handles the low resolution yielding about half as many errors as algorithm from the next most accurate vendor”

Only NEC can handle low resolution

Results shown from the Face In Video Evaluation (FIVE) do not constitute endorsement of any particular product by the U.S. Government. https://www.nist.gov/programs-projects/face-video-evaluation-five
Summary of Matching Accuracy

Error Rate in Ideal Environment (Passenger Gate)

Error Rate in Difficult Environment (Sports Arena)

Higher Performance Evaluation in both ideal and difficult environment

NEC's face recognition technology has robustness in practical applications

Results shown from the Face In Video Evaluation (FIVE) do not constitute endorsement of any particular product by the U.S. Government. https://www.nist.gov/programs-projects/face-video-evaluation-five
Summary

Video Face Recognition Evaluation conducted under various environment conditions by U.S. National Institute of Standards and Technology

*Rank No.1 with High Performance in Video Face Recognition following the Still Image Matching Evaluation*

- Only participant with **over 99% match rate*** in Passenger Gate application
  
  *Error Rate 0.8%

- Achieved high performance in difficult environment

High performance applicable in various practical environment (Walkthrough Identification, Surveillance, etc.)
Direction of Technical Advancement

Realize a system to enable instant detection/identification/tracking of suspicious individuals in a crowd for a safer society

- Identify individuals in an area with millions of people
- Identify suspicious behaviors and track the movement

Early detection of suspects and suspicious individuals to enable preventative measures