FLEXIcross

Flexible & Improved Border-Crossing Experience

for Passengers & Authorities

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FLEXI-cross Results Catalogue

The FLEXI-cross project is dedicated to the deployment and continuous validation of cutting-edge border-checking solutions in real operational environments. By integrating innovative technologies, FLEXI-cross enhances security, reliability, and efficiency in border management for both people and goods.

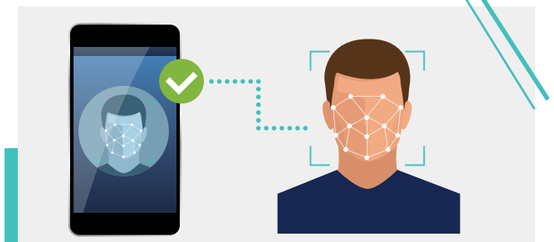
With a focus on flexibility and adaptability, the project introduces dynamic solutions such as mobile border checkpoints and real-time support tools for border personnel, ensuring a high level of security, privacy, and fundamental rights protection.

Technologies

- Biometric Recognition Face Recognition
- Biometric Recognition Personal Data Extraction
- FACE Verification Identification (FACE-VI) Mobile App
- Citizen App
- Organization Risk Assessment
- Visual Analytics Dashboard
- Augmented Reality Situational Awareness
- On Board Unit
- The INtelligent UxV Surveillance INUS UPE Platform
- Context Risk Assessment Platform
- Position Prediction
- Cargo Content Identification
- Event Driven Situational Awareness
- Data Export for Border Authorities

Biometric Recognition - Face Recognition

Biometric face recognition enhances security and efficiency by automating identity verification at borders and access points. Using AI-driven algorithms, it ensures fast, accurate authentication, reducing fraud and unauthorized access while improving operational efficiency and user experience. Its seamless integration with identity management systems modernizes security protocols and streamlines high-security verification processes.



Data Analysis

1. Captures and compares facial images with secure databases for identity verification.
2. Uses advanced algorithms to enhance accuracy and minimize errors.
3. Enables real-time processing for faster, more secure authentication.

Results

Accurately verifies identities by matching facial images with database records.

Enhances security and efficiency by automating identity validation.

Reduces processing time and minimizes human error in verification.

Technologies

OpenCV Library | Haar Cascades Algorithm | Face Identification/Verification Algorithms

Technological Innovation

1. Optimized facial recognition algorithms enhance speed and accuracy of identification.
2. Scalable system allows seamless integration with multiple official identity databases.
3. Improved reliability minimizes human error, strengthening security and trust in authentication.

Impact

1. **Societal:** Enhanced border security and reduced identity verification time.
2. **Economic:** Lower operational costs and optimized resource allocation.
3. **Scientific:** Advancement in facial recognition algorithms and biometric verification models.

Biometric Recognition Personal Data Extraction

Biometric recognition technology utilizes well-defined models for efficient data extraction from National ID cards and passports. This enables seamless processing and verification of personal information, enhancing security and operational efficiency in identification systems.

Data Analysis

1. OCR extracts data from National ID cards and passports.
2. Extracted data is verified and compared with the border-crossing database.

Results

OCR extracts data from National ID cards and passports.

Extracted data is verified and compared with the border-crossing database.

Technologies

OCR enhances data gathering from passports.
MRZ date extraction for accurate identification and processing.

Technological Innovation

1. Advanced OCR improves data extraction accuracy.
2. Automatic Validation against the border-crossing database enhances efficiency.
3. Scalability and Compatibility support various document types (passports, ID cards).

Impact

1. **Societal:** Enhanced security, faster document checks, improved user experience.
2. **Economic:** Lower operational costs, optimized human resources.
3. **Scientific:** Advances OCR and facial recognition, potential for broader applications.

FACE Verification - Identification (FACE-VI) Mobile App

The FACE-VI mobile app and related web-UI is a highly effective face recognition tool designed for use at border control checkpoints. It enhances security and efficiency by quickly verifying the identities of individuals crossing borders, reducing wait times while ensuring that the correct individuals are granted access. By leveraging real-time facial recognition, the app supports seamless and secure processing of travellers, aligning with modern border control practices.

Data Analysis

1. **Face Identification:** Matches a current facial image with a database to identify an individual.
2. **Face Verification:** Compares a current facial image with the one on an ID document to confirm identity.

Results

ID and Verification events, with related images, datetime, and geolocation data for monitoring.

Mis-identification and Mis-verification events, including relevant data, for enhanced operation.

Technologies

Face Detection Algorithms for detecting faces in images.
Deep Learning Models for accurate face verification and identification.

Technological Innovation

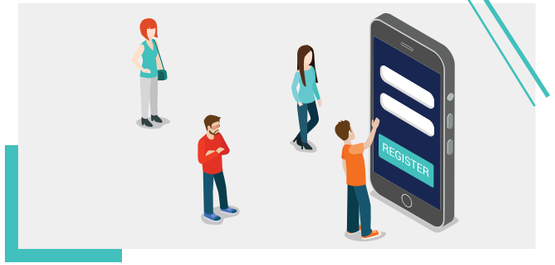
1. Real-time facial recognition for faster, more secure border control.
2. Modern tools such deep learning models.

Impact

1. **Societal:** Delivers efficient, innovative solutions for societal benefit.
2. **Economic:** Enhances cost-effective border security.
3. **Scientific:** Provides a portable, cutting-edge solution.

Citizen App

Citizen App is a dynamic tool that serves as a two-way communication between travellers passing a border control point (BCP) and the administration officers that check for unauthorized entrances and/or movement of prohibited goods. It provides the ability to the travellers to input personal and specialised information about the vehicle to ensure an automated means of identification of persons, vehicles and goods passing from a BCP.



Data Analysis

1. Personal data of travellers and data of goods and vehicles are transferred to a central platform.
2. Provided Data from the travellers is checked and verified with stored data residing in a central platform.

Results

Central platform either provides an alert for further investigation or a soft checking of passengers, vehicles and goods.

Authority officers receive an automated communication from the travellers.

Technologies

Android Package Kit (APK)

Technological Innovation

1. Officers receive automated and specialised information of travellers and vehicles passing through a BCP point.
2. Cross-referencing of citizen app provided data with stored records for accurate identification.

Impact

1. **Societal:** Fast, secure identification of travellers and vehicles.
2. **Economic:** Efficient tool for connecting personal tool like a mobile phone to external platforms.
3. **Scientific:** Facilitates smooth communication of personal data to a central platform.

Organization Risk Assessment

The Organizational Risk Assessment Module is a data visualization dashboard designed for Border Control Personnel (BCP) and authorities to assess and manage security risks effectively. By consolidating various risk instances into a single statistical graph, it provides a comprehensive view of emerging threats and displays trends over time, allowing for proactive security planning.

Data Analysis

1. Aggregates and visualizes risk data for effective resource allocation.
2. Provides clear, actionable risk analytics.
3. Enables predictive analysis of evolving security threats.

Results

Improved risk awareness for timely threat detection.

Strategic decision-making by prioritizing high-risk areas.

Automated visualization for real-time border security insights.

Technologies

Event-driven system of the dashboard retrieves and displays insights scalably and efficiently.

Technological Innovation

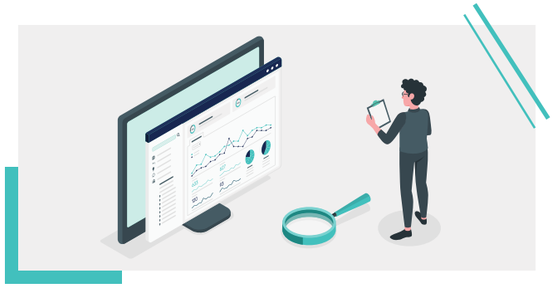
1. Intelligent HMI aggregates data into actionable insights.
2. Enhances strategic decision-making with risk analytics for proactive security management.

Impact

1. **Societal:** Optimized border personnel with better analytics for improved security.
2. **Economic:** Faster detection of anomalies and trends, enhancing operational efficiency.
3. **Scientific:** Utilization of innovative technologies for increased capabilities and traffic management.

Visual Analytics Dashboard

The Visual Analytics Dashboard is a powerful data visualization tool tailored for Border Control Points (BCP) personnel and authorities. Designed for operational efficiency, it provides a comprehensive view of various detection and anomaly instances in real time. The dashboard generates statistical graphs and trend analyses, enabling users to monitor evolving patterns of unlawful activities at a glance.



Data Analysis

1. Identifies unlawful activities, focusing on high-risk areas.
2. Kafka-based backend enables real-time data streaming and anomaly visualization.
3. Trend analysis predicts and mitigates security threats proactively.

Results

Automated graph generation processes and visualizes data instantly.

Real-time intelligence ensures immediate analysis and presentation.

Supports faster decision-making, improving efficiency and security.

Technologies

Event-driven system of the dashboard retrieves and displays insights scalably and efficiently.

Technological Innovation

1. The dashboard is an advanced HMI that transforms data into actionable insights.
2. It analyzes and visualizes real-time data, supporting informed decision-making.

Impact

1. **Societal:** Optimized border personnel with better analytics for improved security.
2. **Economic:** Faster detection of anomalies and trends, enhancing operational efficiency.
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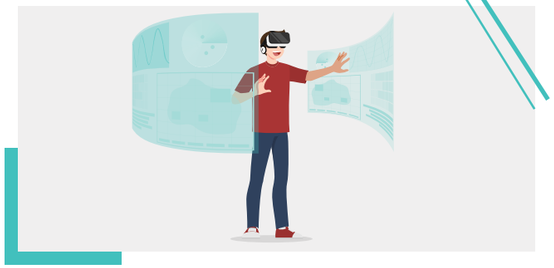
Augmented Reality Situational Awareness

Augmented Reality (AR) technology enhances situational awareness at border control points by overlaying real-time data on the physical environment. It allows border control personnel to visualize and interact with critical information, such as threat assessments, biometric data, and security alerts, directly in their field of view, improving decision-making and response times.



Data Visualisation

1. Pattern extraction, face verification, and identification for security.
2. Risk assessment and detection of contraband, smuggling, and human trafficking.
3. Proof of action and SOS alerts for emergency response.

Results

Real-time visualization of critical information, with proof of actions, image/video capture, and SOS alerts.

Interactive holographic content and integration with the FLEXI-cross toolkit for enhanced functionality.

Technologies

AR Application - VigilAR | Unity Game Engine | XR Streaming
AR Device - Microsoft HoloLens 2 | Server - Windows based Laptop

Technological Innovation

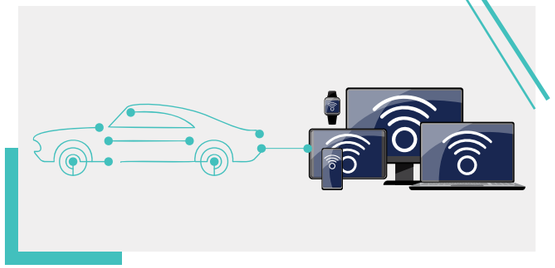
1. Real-time holographic data visualization via XR streaming.
2. Integration of AI-driven threat detection and risk assessment.
3. 3D situational awareness via HMI.

Impact

1. **Societal:** Enhances border safety and personnel experience through AR.
2. **Economic:** Reduces border security costs, streamlines procedures, and offers cost-effective BCP deployment.
3. **Scientific:** Boosts AR security and drives predictive tools and biometrics.

On Board Unit

The on-board unit (OBU) is a crucial component in border control systems, facilitating real-time communication and data exchange between vehicles and border checkpoints. It enhances security by enabling automated vehicle identification, tracking, and verification, ensuring smooth and efficient processing at border crossings.



Data Analysis

1. Vehicle identification and tracking using data from the on-board unit.
2. Real-time data exchange for automated verification and monitoring.
3. Anomaly detection for suspicious activities or unauthorized vehicles.

Results

Real-time vehicle identification and tracking at border checkpoints.

Automated verification of vehicle data for efficient processing.

Detection of anomalies for improved security and monitoring.

Technologies

RFID for automated vehicle identification. GPS for real-time vehicle tracking.
Wireless communication for seamless data exchange between the on-board unit and border systems.

Technological Innovation

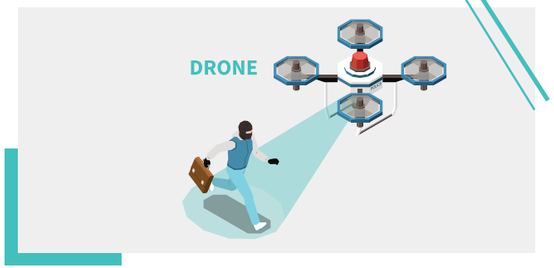
1. Real-time tracking and monitoring of several in-vehicle quantities.
2. Sensor data visualisation.

Impact

1. **Societal:** Enhances cross-border security with real-time vehicle monitoring.
2. **Economic:** Reduces fuel and maintenance costs through efficient tracking.
3. **Scientific:** Advances visualization of in-vehicle capabilities for better analysis.

The INtelligent UxV Surveillance INUS-UPE Platform

The INUS-UPE platform is for crowd dynamics and unusual pattern extraction via video processing from a tethered UAV for real-time situational awareness.



Data Analysis

1. Object detection using deep learning models.
2. Multi-object tracking via tracking-by-detection (TBD) algorithms.
3. Unusual pattern extraction, detecting out-of-bound movements and high-velocity.

Results

Detection and tracking with relevant data (video, datetime, geolocation, telemetry).

Information visualized on control UI, AR Glasses, and web-based UI for enhanced monitoring.

Technologies

Deep learning models for object detection and tracking. Feature extraction and rule-based algorithms for unusual pattern extraction. Geolocation of detected and tracked objects.

Technological Innovation

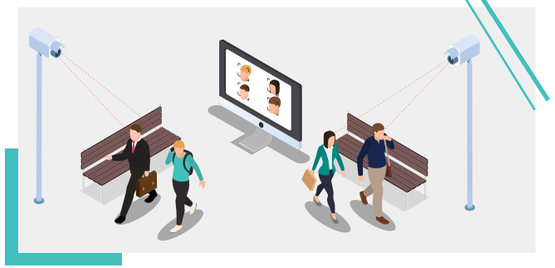
1. Modern tools such deep learning models.
2. Advanced geolocation and minimal latency.
3. Advanced UAV video processing for real-time surveillance.

Impact

1. **Societal:** Enhances operational efficiency and delivers innovative services for public benefit.
2. **Economic:** Contributes to cost-effective and efficient border security operations.
3. **Scientific:** Provides a flexible, modular platform using advanced technologies.

Context Risk Assessment Platform

The Context Risk Assessment platform analyzes incoming data from RSU cameras, from IoT components and from a mobile app to detect potential security threats. It enhances border surveillance by identifying anomalies and assessing risk levels in real time.



Data Analysis

1. Data from travellers, vehicles and goods are identified and, classified for possible threats.
2. Anomaly events coming from vehicles and persons are detected for further inspection.

Results

Authorities can use the platform dashboard to explore risks, access details, track activities, and get alerts on suspicious driving, trafficking, and wildlife crimes.

Web app provides statistics for informed decision-making and risk assessment.

Technologies

RSU cameras, vehicle IoT devices, and a mobile app collect data; AI analyzes behavior and risks; Web platform enables real-time monitoring and stats.

Technological Innovation

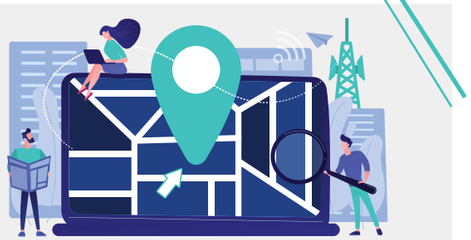
1. Advanced pattern recognition to identify high-risk behaviors with greater accuracy.
2. Automated risk evaluation to enhance decision-making and reduce manual analysis.

Impact

1. **Societal:** Improved security at the cross border.
2. **Economic:** Decreased operational costs.
3. **Scientific:** Fosters global collaboration between BCP authorities and provides an essential tool for the authorities to check faster BCP points.

Position Prediction

The Position Prediction module detects sounds and classifies them into specific categories. It then predicts the approximate location where the sound originates, enhancing situational awareness for security operations.Data analysis: Sound data analysis and classification.



Data Analysis

1. Classifies sounds into categories using audio algorithms.
2. Predicts location of sound origin for security analysis.

Results

Geographic coordinates of sound origin.

Sound classification for security event identification.

Technologies

YAMNet algorithms for sound classification.
OpenL3Classifier library for audio feature extraction and analysis.

Technological Innovation

1. Precise sound classification with advanced algorithms.
2. Real-time localization of sound sources for faster response.

Impact

1. **Societal:** Enhances public safety through automated sound detection.
2. **Economic:** Reduces surveillance costs and improves intervention speed.
3. **Scientific:** Integrates audio analysis with AI for advanced monitoring.

Cargo Content Identification

Leverages blockchain technology for secure and tamper-proof cargo content verification. By recording key parameters on a decentralized ledger, it enhances transparency, traceability, and trust in cargo identification processes.

Data Analysis

1. Extracts and verifies cargo identity, unique cargo ID, and country of origin for enhanced tracking and security.

Results

Detects discrepancies in cargo data and identifies goods from restricted or high-risk areas, such as pandemic zones or regions with high emigration.

Technologies

Blockchain networks (PyChain).

Technological Innovation

1. Secures cargo verification with Blockchain, ensuring tamper-proof data.
2. Enhances traceability through decentralized record-keeping.

Impact

1. **Societal:** Improves security, transparency, and public health by identifying suspect goods and detecting high-risk items.
2. **Economic:** Enhances logistics efficiency and prevents losses by validating goods' origins and reducing risks.
3. **Scientific:** Expands blockchain in border security and standardizes transport systems.

Event Driven Situational Awareness

EDSA aggregates data coming from heterogenous sources such as drones cameras, mobile devices, Augmented Reality situation Awareness, and from acoustic sensors, to optimize the display of information, facilitating the interpretation of real-time events.

Data Analysis

1. EDSA perform minor aggregation on data.

Results

Geo-temporal visualization of anomalies, risks, and detections.

SOS and Ack real-time display of Augmented Reality GUI.

Video streaming from AR GUI and mounted camera on a tethered drone.

Technologies

Front-End: Angular (Signals, Leaflet, Janus, etc.) | **Back-End:** Java, RESTHeart
Integration/ETL: Apache Camel, NiFi

Technological Innovation

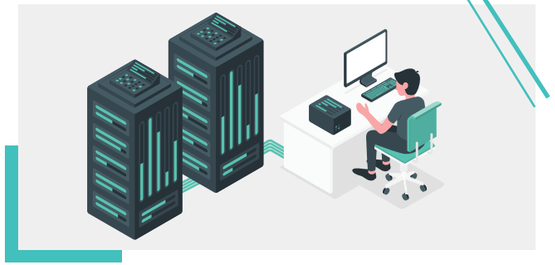
1. EDSA integrates multiple data sources into a unified view of situational awareness through advanced visualisation tools, a modern technological stack, and powerful integration tools.

Impact

1. **Societal:** Improved situational awareness enables faster emergency response in secure areas.
2. **Economic:** Automation and informed resource use reduce costs and boost efficiency.
3. **Scientific:** This module was developed to meet FLEXI-cross project needs and end-user capability gaps.

Data Export for Border Authorities

The Data Export module allows external tools to seamlessly access and leverage event data, providing a powerful means to integrate and analyze real-time insights for advanced processing, decision-making, and reporting. This ensures smooth data flow and enhances the value of event-driven information across diverse applications.



Data Analysis

1. Data is filtered based on the user's access level and data sensitivity.
2. Data is transformed into the desired format using ETL technologies.

Results

Enables seamless interoperability with external systems.

Secure, scalable, and privacy-preserving data export.

Technologies

ETL: Apache Camel | **Access Control:** Role-Based Access Control (Keycloak)
Data Privacy: Privacy by design

Technological Innovation

1. Technologies are combined to deliver a configurable, scalable data export functionality compliant with EES data model.

Impact

1. **Societal:** Enhances data privacy and security, fostering trust in data sharing.
2. **Economic:** Reduces costs by streamlining data integration and accelerating BCP checks.
3. **Scientific:** Delivers concrete and measurable results and knowledge that are envisaged to influence the technological capabilities in border security.

Consortium

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