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Features

- Full design framework for real-time vision-based Automotive Driver Assistance Systems (ADAS)
- Based on Xilinx® Zynq®-7000 All Programmable System on Chip (SoC)
- Includes full Driver Assistance (DA) demos:
  - logiOWL Vehicle Self Calibration – quick and effortless automated system calibration
  - 360° Surround View (3D and bird's eye views)
  - Forward Looking Pedestrian Detection with the Range Estimation
  - Rear-View Camera (several modes)
  - Lane Departure Warning (LDW)
  - Blind Spots Detection
  - Face Detection and Tracking
- Reference Zynq-7000 AP SoC designs for Xilinx Vivado® Design Suite with evaluation IP cores
- Linux OS, software drivers, APIs and post-processing libraries, documentation

- logiADAK Builder – PC application for logiADAK Low-Velocity viewing modes customization
- Calibration SW for adoption to a specific vehicle:
  - Surround View calibration software (logiOWL)
  - Pedestrian Detection calibration software
  - Rear-Looking LDW calibration software
  - Blind Spot Detection calibration software
- A complete hardware platform:
  - Xilinx Zynq-7000 SoC ZC706 Evaluation Kit[*]
  - Xylon FMC board for six camera connections
  - 5x Xylon weather-proof (IP67) camera housing
  - 5x OmniVision OV10635 HDR camera sensor
  - 4x Sunex DSL219 + 1x DSL947 fisheye lens
  - 5x Xylon Camera TX LVDS camera serializers
  - Power supply and cabling suitable for vehicles
- All-in-one platform is open for customizations
- The kit can be installed in test vehicles
- 25 hours of tech support (e-mail)

Figure 1: The logiADAK Zynq-7000 AP SoC Automotive Driver Assistance Kit

* OEM kit version, does not include cables, SD card and software (seat Vivado Design Suite)

Applications

- Surround View (3D views and Bird's Eye View), Pedestrian Detection, Rear-View Camera, Lane Departure Warning, Blind Spot Detection, Face Detection and Tracking and other emerging video-based ADAS
- Surveillance (360° Panoramic Camera), aerospace and defense, test and measurement equipment…

General Description

The logiADAK Automotive Driver Assistance kit is Xilinx Zynq-7000 All Programmable System on a Chip (SoC) based development platform for advanced automotive Driver Assistance (DA) applications that require intensive real-time video processing, parallel execution of multiple complex algorithms and flexible interfacing with sensors and vehicle's communication backbones.

The logiADAK kit can be leveraged to quickly bring new Driver Assistance innovations to market. It provides Automotive Driver Assistance System (ADAS) designers all the resources they need to efficiently develop vision-based DA systems, save months of development time and focus efforts on system differentiating functions and performance. The kit comes with a full set of DA demo applications, customizable reference SoC designs with evaluation IP cores, software drivers and libraries, calibration software and documentation.

The included DA demo applications use several Zynq-7000 AP SoC designs to reprogram (reuse) the Programmable Logic (PL) and support different feature bundles suitable for different driving conditions. This ultimate re-programmability, which occurs under the continued supervision of the ARM® Cortex™-A9 processors in the Processor System (PS), saves silicon resources and enables use of smaller and more cost efficient Zynq-7000 SoC.

A powerful combination of hard-coded and programmable logic on a single Zynq-7000 SoC enables ADAS designers to design SoCs that outperform competing solutions, and to achieve a new level of system differentiation through a combination of hardware-accelerated functions implemented in the programmable logic and familiar software-based DA functions running on powerful ARM processors.

The logiADAK hardware platform and calibration software are appropriate for quick test vehicle installations and rapid engagements in proof-of-concept or demonstration projects. The new logiOWL Vehicle Self Calibration feature (first time introduced with the kit v3.0) enables automatic end of line camera calibration that helps OEM automakers and Tier-1 suppliers improve design accuracy, reduce manufacturing cost due to manual calibration process, and reduce time on final test and validation.

logiADAK Demo Driver Assistance Applications

The included Driver Assistance demo applications can be evaluated on real vehicles, adopted for specific requirements, merged with user's innovation and efficiently developed into products.

The demos are provided via three Xilinx Zynq-7000 All Programmable SoC configuration designs, which are used in different driving conditions. Depending on the vehicle's velocity, the Zynq-7000 SoC programmable logic can be configured with a different set of custom hardware accelerators.

Low-Velocity Driving Applications Set:

- logiOWL Vehicle Self Calibration – quick and effortless automated system calibration
- logiADAK Builder allows for Low-Velocity system customization – PC application with the preview option for setting up any number of Surround View, 3D Surround View or Single View modes
- 360° Surround View: 3D viewing modes and bird's eye viewing mode
- Pedestrian Detection and Range Estimation
- Rear-View Camera: uncorrected video, distortion correct view, trailer-hitch mode, cross path mode, dynamic paths…

High-Velocity Driving Applications Set:

- Lane Departure Warning (using rear-view camera)
- Blind Spots Detection (using side-view cameras)

In-Cabin Set:

- Face Detection and Tracking demo (using the 5th camera)

Future planned designs will make use of the Xilinx partial reconfiguration feature which enables exchange of only a portion of custom hardware accelerators implemented in the programmable logic while other accelerators work in an uninterrupted fashion. Xylon offers assistance and technical support for partial reconfiguration implementations. For more information, please contact Xylon Support Team at support@logicbricks.com.

logiOWL Vehicle Self Calibration
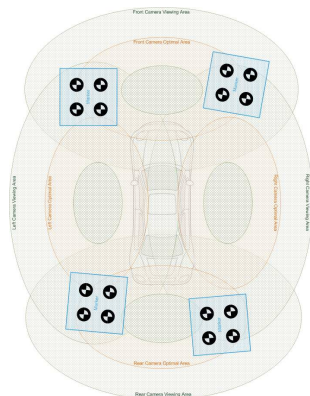
logiOWL[*] enables automatic end of line camera calibration. It runs fully embedded in the vehicle and enables full vehicle level multi-camera calibration in as little as 10 seconds. The process is simple and inexpensive, does not require a complex calibration site, and can be executed easily in repair shops without specialized training for service personal.

* Filled patent application

**Figure 2: logiOWL markers setup example**

logiADAK Builder
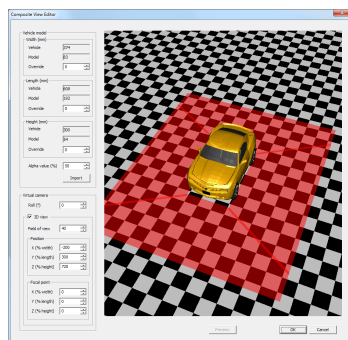
The logiADAK Builder implements a convenient PC user interface towards the target ADAS system embedded in a vehicle. It enables quick customizations of Low-Velocity system features modes and mode views. All previews are done on the target and there is no mismatch between the PC settings and the final target system settings. Required vehicle calibration data and customized views must be setup once for the specific vehicle model. In combination with the logiOWL Vehicle Self Calibration, the determined setup enables quick and precise vehicle self-calibration suitable for volume production.

Figure 3: logiADAK Builder example

360⁰ Surround View
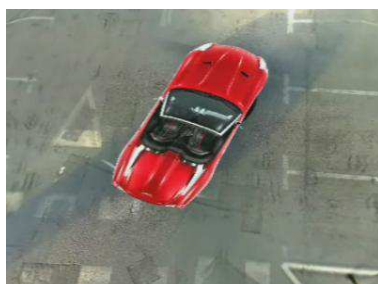
The Surround View (SV) parking assistance enables the driver to see 360° surroundings around the vehicle from different perspectives, including 3D visualized views from the programmable point of view and the top-down bird's eye view perspective. Such views eliminate all blind spots during critical and precise maneuvers in different traffic situations. The logiADAK deliverables include the full four-camera SV setup. For more information about the six-camera SV setup suitable for larger vehicles including commercial trucks, please contact Xylon.

Figure 4: 3D Surround View

Pedestrian Detection and Range Estimation

Pedestrian Detection with tracking capability for forward camera collision avoidance alerts the driver in case a person is detected in the area surrounding the vehicle along the moving direction. The level of warning is based on the estimated distance range. Pedestrian Detection application fields cover also video surveillance, robot navigation, assistive technology for the visually impaired, content-based indexing, and advanced human-machine interfaces.

Figure 5: Pedestrian Detection

Rear-Looking Lane Departure Warning
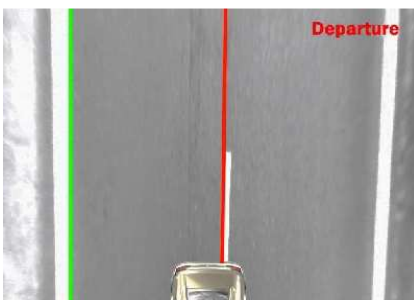
Lane Departure Warning (LDW) DA systems track the markings corresponding to the lane boundaries, locate the vehicle position with respect to them and issue a warning when the vehicle crosses the lane borders. The Rear Looking Lane Departure Warning systems work with a common back-up camera typically used for Rear-View applications with no need for additional camera sensors.

Figure 6: Lane Departure Warning

Face Detection and Tracking

The face detection and tracking tracks the face and facial features in video sequences in real time and returns full 3D head pose, gaze direction, facial features coordinates and a wealth of other information. This computer technology significantly improves human-machine interaction and can be used in a very wide range of in-cabin ADAS applications, such as a driver drowsiness detection, lane departure prevention, in-cabin surveillance for taxi fleet management, etc.

**Figure 7: Face Tracking**

Blind Spots Detection
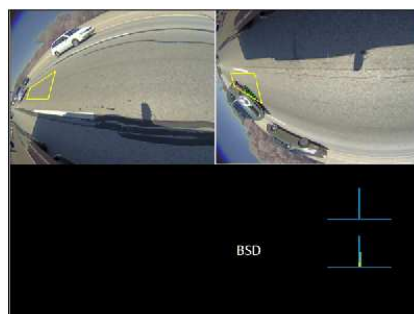
The Blind Spot Detection collision avoidance DA uses side-view cameras to provide a driver with information about objects that are outside his range of vision – in the blind spots (areas) to both sides of a vehicle. The system is able to detect the presence of objects in the blind spots and inform the driver about it. Depending on the vehicle's velocity, the side-view cameras are used by the Blind Spots Detection (high velocity) or the Surround View DA (low velocity).

The key IP cores and software for the Blind Spots Detection applications are sourced from Digital Design Corporation (DDC).

Figure 8: Blind Spots Detection

logiADAK Hardware Platform
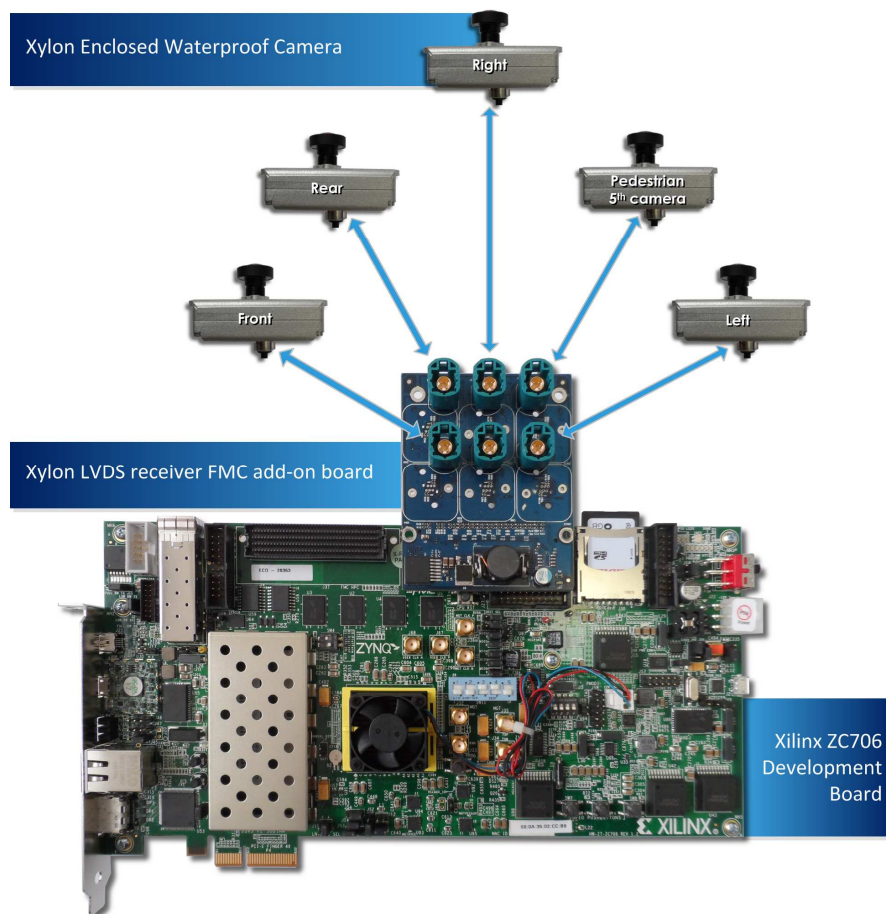
Figure 9: The logiADAK Kit Hardware Platform – System Connections

The logiADAK hardware platform includes the Xilinx Zynq-7000 SoC ZC706 development board, the FMC add-on board for connections of up to 6 HD video cameras, five camera sensors, LVDS serializers for video transmissions from the camera sensors towards the FMC receiver board, fisheye lenses and a full cabling set.

The platform also includes five camera systems in weather-proof (IP65) aluminum housing designed by Xylon. Each system includes OmniVision OV10635 1-megapixel camera sensor that combines high-definition 1280x800p30 WXGA (HD) video with the color high dynamic range (HDR) functionality, LVDS serializer (transmitter) board designed and the appropriate lens. The 5th camera, which is used for Pedestrian Detection and Face Detection and Tracking, comes equipped with the Sunex DSL947 Narrow Field of View (FOV) miniature lens. The other four cameras are equipped with the Sunex DSL219 miniature fish-eye Wide FOV lenses.

Reference SoC Designs

The logiADAK Automotive Driver Assistance Kit comes with several pre-verified reference designs that showcase different hardware accelerators and software solutions for Driver Assistance applications. Kit users can customize logicBRICKS, DDC and Xilinx IP cores through the Vivado IP Integrator (IPI) GUI, optimize feature sets, control the utilization of programmable logic resources, and in a drag & drop fashion, implement Xilinx Zynq-7000 All Programmable SoC without hand coding.

To see block diagrams of the reference designs included with the kit, please visit:

http://www.logicbricks.com/Solutions/Xylon-ADAS-Development-Kit/logiADAK-Reference-SoC-Designs.aspx

logiVIEW Perspective Transformation and Lens Correction Image Processor

logiVIEW Perspective Transformation and Lens Correction Image Processor IP core is the key IP core for the design of the Surround View and similar multi-camera systems. This IP core removes fish eye lens distortions, makes perspective corrections to all camera video inputs and stitches the resulting single image in real-time. A programmable homographic transformation matrix enables different perspective transformations, such as rotating, resizing, translating, cropping, as well as simultaneous combinations of all of these transformations. In addition, the logiVIEW IP core can transform the video image in arbitrary ways by optional Memory Look-Up Tables (MLUT), i.e. 3D visualization of vehicle's surroundings in automotive driver assistance applications (3D Surround View, Figure 4).

Find more information about Xylon's logiVIEW IP core by visiting www.logicbricks.com/Products/logiVIEW.aspx.

logiPDET Pedestrian Detector

logiPDET is an HOG/SVM-based pedestrian detection IP core developed for vision-based embedded applications. The algorithm follows a discriminative approach. It combines a HOG-based descriptor and a SVM classifier. The HOG (Histogram of Oriented Gradients) is a descriptor designed to encode pedestrian structure. The SVM (Support Vector Machine) is a non-probabilistic binary linear classifier. The core works at a single scale, i.e. the classifier is trained to recognize pedestrian at a fixed size. Extension to multiple scales is given by inserting the core in a framework that provides it with a sequence of re-scaled versions of the same input frame. In this way it is possible to detect pedestrians moving in an arbitrary range of distance.

Find more information by visiting http://www.logicbricks.com/Products/logiPDET.aspx.

logiLMD Lane Marking Detector

logiLMD IP core detects the lane markings on the roadway captured from a rear view camera. Its functions include image-processing filters, like Gaussian smoothing and Edge detection, and blocks specifically tailored for lane marking detections. The output of the core is a set of straight lines corresponding to the lane markings.

Find more information by visiting http://www.logicbricks.com/Products/logiLMD.aspx.

logiFDT Face Detector and Tracker

The logiFDT Face Detector and Tracker IP core finds and tracks the face and facial features in video sequences in real time and returns full 3D head pose, gaze direction, facial features coordinates and a wealth of other information. It is carefully partitioned between hardware and software to assure the highest performances (i.e. 30fps) and optimal utilization of the Xilinx Zynq-7000 AP SoC.

Find more information by visiting http://www.logicbricks.com/Products/logiFDT.aspx.

logiWIN Versatile Video Input

logiWIN IP core accepts a streaming video input, decodes it, and converts into the RGB format. The input video can be real-time scaled, de-interlaced, cropped and positioned on the video display. The logiWIN integrates high-quality anti-aliasing algorithm that guarantees high picture quality without visible artifacts.

Find more information by visiting www.logicbricks.com/Products/logiWIN.aspx.

logiCVC-ML Compact Multilayer Video Controller

The logiCVC-ML IP core is an advanced display graphics controller for LCD and CRT displays, which enables an easy video and graphics integration into embedded systems with Xilinx Zynq-7000 SoC and FPGAs. Though its main function is to provide flexible display control, with resolutions up to 2048x2048 pixels, it also includes a level of hardware acceleration: alpha blendings, panning, buffering of multiple frames, etc. Xylon provides an extensive logiCVC-ML software support for the most popular operating systems (OS).

Find more information by visiting www.logicbricks.com/Products/logiCVC-ML.aspx.

BSD Blind Spot Detection using optical flow motion estimation

The optical flow field is used to estimate the 2D motion projected on the image plane by the objects moving in the 3D scene. Graphical representation of the optical flow vectors is through the use of overlays on the original image. The Zynq SoC Processing System (PS) is used to analyze statistics of the vectors in user defined blind spot regions and to determine if there is a valid detected object.

The BSD IP cores and software for the Blind Spots Detection applications are sourced from Digital Design Corporation (DDC).

For more information about the BSD, please contact DDC (http://www.digidescorp.com/).

logiOWL Vehicle Self Calibration and the logiADAK Builder

A set of Xylon IP cores and related software enables automatic end of line calibration. While traditional electronic means of alignment are challenging, time consuming and require specialized calibration environments, Xylon's end of line calibration solution runs fully embedded in the vehicle and takes only seconds for full multi-camera calibration. The solution is precise, simple and inexpensive and does not require a complex calibration site.

The logiOWL Vehicle Self Calibration runs fully and autonomously on the target ADAS system. The logiADAK Builder provides an optional and convenient user interface via Ethernet to enable customizations of viewing modes used in the embedded target ADAS system.

Figure 10: The logiADAK Builder System Connections

Package Content

Hardware

- 1x Xilinx Zynq-7000 SoC ZC706 Development Kit[*] with XC7Z045 FFG900 -2 AP SoC[**]
- 1x Xylon LVDS receiver FMC add-on daughter card for up to 6 camera connections (ZC706 side)
- 5x Xylon Enclosed Camera Systems (each system contains the Xylon LVDS serializer board for camera sensors, OmniVision OV10635 1Mpix camera sensor, 4x Sunex DSL219 and 1x DSL947 miniature lenses and weather-proof (IP65) aluminum camera housing designed by Xylon)
- 4x Vehicle Calibration Carpets[***] and 4x Model-Sized Calibration Carpets (for use on lab desks)
- 1x SD card
- 1x USB memory stick with software deliverables

  [*]   *OEM kit version, does not include cables, SD card and software (seat Vivado Design Suite)*

  [**]   *Reference designs provided with the kit use just a fraction of available programmable logic resources. The ZC706 hardware platform has been selected to enable more advanced future ADAS developments.*

  [***]   *Internationally registered industrial design*

Reference FPGA Designs

The reference SoC designs are prepared using Xilinx Vivado tools, version 2014.2. Each SoC design supports several demo applications.

Low-Velocity Demo:

- Main DA applications: 360° 3D Surround View, Pedestrian Detection, Rear View Camera width dynamic path lines, Picture-in-Picture (PiP) modes and dynamic calibration

High-Velocity Demo:

- Main DA applications: Lane Departure Warning (using Rear Camera), Blind Spot Detection (using side cameras)
- Each application has user defined parameters that can be set via a UART interface to define alert zones, set thresholds, and calibrate the installation for different vehicles

Face Detection and Tracking:

- Detection of a single and multiple faces in the video image, and tracking of facial actions - configurable number of the tracked Face Animation Parameters (FAP) defined by the MPEG-4 specifications

Xylon logicBRICKS and DDC IP Cores*

- logiVIEW Perspective Transformation and Lens Correction Image processor
- logiCONTOUR – Closed Contour Detector
- logiPDET Pedestrian Detector
- logiLMD Lane Marking Detector
- logiFDT Face Detector and Tracker
- logiWIN Versatile Video Input
- logiCVC-ML Compact Multilayer Video Controller
- logicBRICKS LVDS camera interface
- BSD Blind Spot Detection using DDC Optical Flow Motion Estimation

* The kit deliverables include evaluation IP cores! For quick information on how to register, get evaluation IP license and other general information, please visit: http://www.logicbricks.com/logicBRICKS/logicBRICKS-Quick-Info.aspx

Applications and Drivers

- Demo applications in source code
- logiADAK Builder
- logicBRICKS standalone (bare-metal) and Linux drivers with examples
- Zynq-7000 FSBL sources
- Xylon precompiled utility libraries

Documentation

- logiADAK User's Manual
- logiADAK Low-Velocity Application User's Manual
- logiADAK High-Velocity Application User's Manual
- logiADAK Vehicle Setup Guidelines
- logiPDET Calibration and Setup User's Manual
- Blind Spot Detection User's Manual (DDC)
- RLDW Calibration and Setup User's Manual
- logicBRICKS User's Manuals

Cabling and Adapters

- power supply
- 5x long cables for camera interfacing; suitable for vehicle installations

Recommended Design Experience

The users, who want to make changes on the provided designs, should have experience in the following areas:

- Xilinx design tools
- Xilinx System Generator
- C programming

The provided evaluation IP cores are fully compatible with the Xilinx Vivado implementation tools and their use does not require any particular skills beyond general Xilinx tools knowledge.

Design Services

The provided reference SoC designs enable differentiation through innovation and save months of development time. Design services are available to customers interested in customization and enhancement developments based on the presented hardware and software products.

Related Xylon Products

Computer vision applications (including ADAS) require quality video input. Xylon's logiISP Image Signal Processing Pipeline IP core is a full high-definition ISP pipeline designed for digital processing and image quality enhancements of an input video stream in Smarter Vision embedded designs based on Xilinx Zynq-7000 All Programmable SoC and 7 Series FPGA devices. Free logiREF-VIDEO-ISP-EVK pre-verified reference design for the Zynq-7000 AP SoC based MicroZed Embedded Vision Kit from Avnet Electronics Marketing is available from:

Email: support@logicbricks.com
URL: http://www.logicbricks.com/logicBRICKS/Reference-logicBRICKS-Design/ISP-Pipeline-for-Xilinx-All-Programmable.aspx

Ordering Information

This product is available directly from Xylon. Please visit our web shop or contact Xylon for pricing and additional information:

Email: sales@logicbricks.com
URL: http://www.logicbricks.com/Products/logiADAK.aspx

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Related Information

Xilinx Programmable Logic

For information on Xilinx programmable logic or development system software, contact your local Xilinx sales office, or:

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Phone: +1 408-559-7778
Fax: +1 408-559-7114
URL: www.xilinx.com

Revision History

Version	Date	Note
1.00	17.12.2012	Initial release.
2.00	15.02.2013	The first public release. Kit updated with the Blind Spots Detection using side-view cameras.
2.00	23.10.2013	BSD IP core name changed, Xilinx tools version set to 14.6.
2.01	23.09.2014	Increased rev. to match release rev.
3.0	05.02.2015.	logiOWL, logiADAK Builder, Face Detection and Tracking, upgraded to new board ZC706, camera hot plug and camera lens data stored in camera.

The logiPDET and the logiLMD cores are sourced from Technology Partner
eVS embedded Vision Systems Srl.

The key IP cores and software for the Blind Spots Detection applications are sourced from Digital Design Corporation (DDC).

visage I SDK™ Face Track tracking engine is sourced from Technology Partner
Visage Technologies AB.