Augmented reality (AR) applications consist in embedding virtual 3D objects into a real world live video.

With the addition of interactivity, AR has gained popularity in the consumer market for gaming or advertising. Industry professional uses also the AR in the area of assisted training for skilled jobs.

AR in industrial environment

Industrial environment requires very high reliability, accuracy, support of very complex 3D models (millions of vertices), and high video resolution all with a good autonomy on battery powered devices for onsite maintenance operation.

MPPA MANYCORE processor provides breakthrough in computing area with one of the best ratio computing capability versus power consumption compared to traditional embedded solutions. This performance level opens the door to new area of AR application in the industry.

- Assisted maintenance of complex and critical industrial installations
- Automatic generation of 3D models from camera views
- Check conformity of manufactured objects versus the 3D models generated with CAD tools.

Benefits of MPPA for AR applications

MPPA-256, first member of MPPA MANYCORE family has 256 cores, 32MB of embedded static memory, and high speed interface, well adapted to stream video.

AR applications use highly parallel algorithm executing perfectly on massively parallel structure of MPPA.

The possibility of connecting together several MPPA MANYCORE provides a scalable compute power to address increasingly complex AR applications with the same processor.

Computing power of MPPA MANYCORE provides new level of performances for AR applications:

- High Definition video
- Better accuracy to match small elements (~1mm)
- Possibility to manage large and complex models
- Real Time analysis of complex objects

Matching 3D model with real life

The key part of embedded vision systems is the SLAM (Simultaneous Location and Mapping). This algorithm reconstructs a 3D map of real scene, and at the same time computes the exact position of the camera into the scene.

A second algorithm is used to match 3D map of the real scene and the 3D model (see fig. 1).

The 3D model is commonly made from CAD tool or from a laser scan. The size of such model is linked to the complexity of the object and can be very large (several GB).

Figure 1: 3D location and matching of a gas panel

Matching small objects (~1mm) or large and complex facility installation models requires large image resolution and consequently high computing capability to process those pictures.

MPPA MANYCORE computing capability and massively parallel architecture help significant breakthroughs by efficiently executing complex algorithms such as SLAM on the 256 cores of the MPPA.

With MPPA MANYCORE, SLAM executes a VGA 30Hz with 150MB of data model (6x better than current systems).
Augmented Reality for Industrial Application

MPPA MANYCORE processor proposes several operating mode for AR:
- An acceleration mode
- A remote server
- A standalone embedded system

AR applications in acceleration mode

In this mode, the MPPA MANYCORE is used to accelerate some part of the code running on the host. The main application runs under the host operating system and communicates with the MPPA MANYCORE though PCIe interface.

The PCIe driver provided by Kalray performs synchronization between host and MPPA MANYCORE using message queues.

MPPA MANYCORE sends back to the host the camera location and the position of the model in the real scene.

Rendering operations on the video are performed by the GPU connected to the host. In this mode, the camera is connected to the host using a firewire high speed link.

Embedded AR application

In this mode, the MPPA MANYCORE and a low power processor module integrating a CPU and GPU are on the same board and connected thru PCIe link. MPPA MANYCORE is used in acceleration mode of the host CPU, while the GPU is used for rendering. This board proposes a complete portable and standalone AR application with an overall power budget below 30W.

Library for AR applications

Kalray proposes a library of most popular vision functions optimized for MPPA MANYCORE:
- Levenberg Marquart optimization
- Harris detection
- Extended Kalman filtering
- 2D Gaussian filters
- Deriche edge detector
- SLAM (simultaneous location and mapping)
- Bundle adjustment