



For a leading position of Europe in Embedded & Cyber-Physical Systems

Eyes of Things

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- Horizon 2020, EU Framework Programme for Research and Innovation
- 2014-2020







Eyes of Things, H2020 Innovation Action

- Topic: Smart cyber-physical systems
- Innovation-Type Action

R&I Action: "Novel solutions to old applications" Innovation Action: "Novel applications with old solutions"

• Started Jan 1st, 2015. Budget, 4M€







Vision is our richest sensor

One of the most complex tasks for both humans and machines

Proven success in 'machine vision' context, i.e. factory automation, inspection,...





CV is going out-of-factory ...

- Microsoft Kinect
- Google Project Tango
- Google Glass

Lots of new developments

- Drones
- ADAS
- Multispectral, 3D, ...
- Mobile imaging
- Deep learning

















 Many innovative
 'out-of-the-factory' CV applications developed for smartphones, which are cheap, easy-to-use ...





- But smartphones are not appropriate for many applications
 - Wearable for the EOT? No
 - Low power consumption? No
 - Optimized for CV? No
- No flexible open platform for mobile embedded vision is currently available
- New-platform needed







Other devices?

- IoT devices:
 - WaRPboard, Ambarella, Intel EDISON, Ingenic Newton2, Nixie...



- Most of these systems process data from scalar sensors
- Some can be attached to cameras, but not do CV
- NONE has been designed from bottom-up with vision in mind !





Efficiency



Cost



Size



Flexibility





Challenges



Build a generic vision system that can be used standalone but also embedded in more complex artifacts

BOM < \$15





EoT Platform: Hardware

Movidius Myriad2 Optimum performance for CV vs power consumption, size and cost







EoT Platform: Hardware

Awaiba's NanEye camera

- World's smallest digital camera
- Power consumption
 < 10mW
- Disposable





EoT Platform: Hardware

Texas Instruments CC3100

- •20x17 mm
- Low-cost, low-power
- Internet-on-a-chip: integrates all protocols
- Supports Station and Access Point modes





EoT Platform: Software

Library/API	Туре	Processing
OpenCV	Computer vision	Local and Cloud
ΜνϹν	Computer vision	Local
Libccv	Computer vision	Local
Google Cloud Vision API	Computer vision	Local
Quirc	QR code recognition	Local
MvCNN	Convolutional Neural Networks	Local
MvBot	Robotics applications	Local
Opus	Audio	Local
RTSP	Video streaming	Local
MicroPython	Scripting	Local
MQTT	Messaging	-
Google Cloud Pub/Sub	Messaging	-



- In EoT we selected **MQTT**
- Open lightweight publish/subscribe protocol
- Efficient 1-to-n communication mechanism

TABLE I.MQTT vs HTTPS, send performance

	3G		WiFi	
	HTTPS	MQTT	HTTPS	MQTT
Messages/hour	1926	21685	5229	23184
% Battery/Message	0.00975	0.00082	0.00104	0.00016



MQTT Broker: Pulga

It is used for communication





The broker is embedded in the EoT device!







- Computer Vision library **optimized for the EoT device**
 - Application example: Tracking







- Computer Vision library
 - Application example:
 - Canny Edge Detection + RTSP Streaming







- Portable and Embeddable
- Modern Computer Vision Algorithms
- Clean Interface with Cached Image Preprocessing
 - Application Example: Text Detection



https://github.com/liuliu/ccv



Quirc

• QR recognition





MvBot

• EoT devices can control other hardware





Rotation Invariant Face Detector





MicroPython

- EoT device programming language = C/C++
 - We have added a MicroPython console!

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4 demonstrators will be developed using the EoT platform

1. Peephole Surveillance





4 demonstrators will be developed using the EoT platform

2. Hands-free automatic museum audio guide





4 demonstrators will be developed using the EoT platform

3. Doll that recognizes child emotions





4 demonstrators will be developed using the EoT platform

4. Wearable lifelogging camera





Conclusions

'Computer vision' connected platform

Foreseen for September 2016

Demonstrators

Foreseen end of 2017



 \rightarrow An important stake with potential numerous applications!





http://www.eyesofthings.eu

