



Mixed Reality Solutions for Industry 4.0: Real Cases



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Industry 4.0 & IIoT

Recent IIoT (Industrial Internet of Things) developments are interesting for their capability to extend also already existing capabilities and to gather large amounts of data that enable the introduction of new solutions able to integrate distributed systems and new components within networks. Due to these considerations, it is possible to develop innovative solutions for monitoring, tracking and maintenance in industrial plants and to support operations on them. The availability of data is one of main reasons why nowadays it is common to test and introduce new solutions based on Artificial Intelligence (AI), Digital Twins, Augmented Reality (AR) as well as on Autonomous multi-domain Vehicles (AxV).





Previous Experience



In the past the authors conducted various experiments on different solutions, devices and platforms to improve safety in industrial plants. For instance, there were tested solutions based on tablets and smartphones and CAVEs





Technologies for Operator: Smartphones and Tablets



Mobile Applications could allow instant access to parameters of machines and production lines

DATA	TIPO	MACCHINA
9/2/2018 12:41:03	Pulizia vetro	Somex
9/2/2018 12:47:05	Cambio Cartuccia	IS
9/2/2018 16:48:42	Camb. press.	IS
9/2/2018 20:51:32	Pulizia vetro	Macc-tratt-cald
9/2/2018 23:55:19	Sost. cavo dati	Tiama MX4
10/2/2018 02:04:36	Sost. Mat. Refrat.	IS

BACK





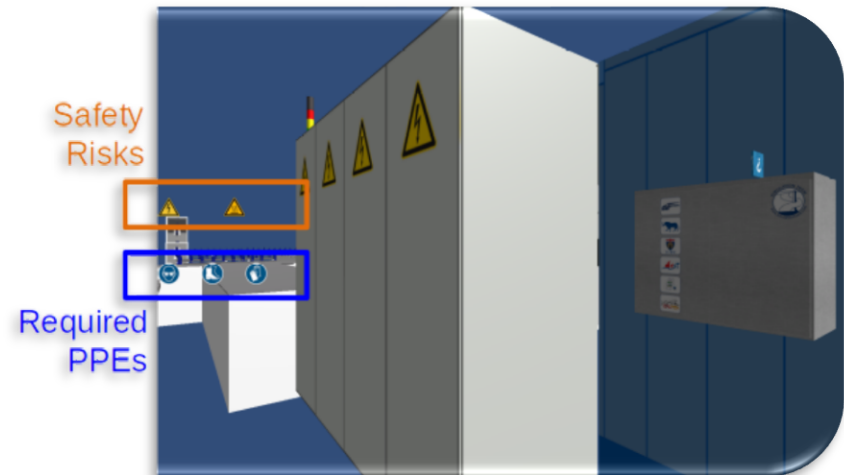
Technologies for Operator: Virtual Reality



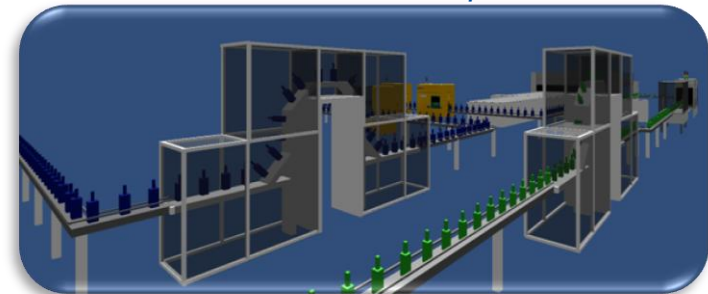
*Oculus
Rift
Headset*



*Foto of production line
(cold treatment machine)*



*Virtual representation of plant with augmented
information: risks and required PPEs*



Virtual model of production line



Technologies for Operator: Augmented Reality



Hololens AR headset

Display of the
electric switch,
which works as
ON/OFF button
in the AR
application



QR code for
positioning

LED
indicators
of state



Machine control panel for testing

Camera synchronization



Mixed Reality: Augmented & Virtual Reality for Training



Training using AR in HoloLens



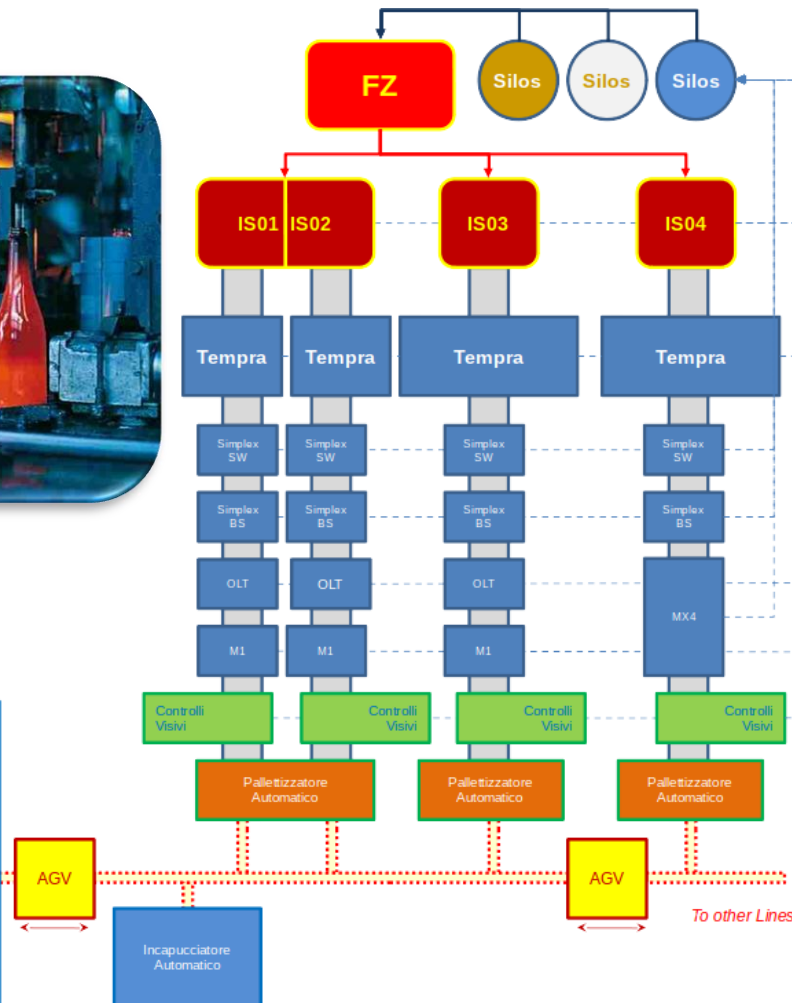
Virtual Reality at Work for Training & Education

Training using VR in Oculus Rift

In many cases it is possible to employ same solutions to multiple tasks, such as training, problem solving, assessment, remote assistance and supervision.



A Case Study: Hollow Glass Production Line





Analysis of Risks

$$AR = \frac{N}{EH} 10^6$$

AR – accident rate

N – total number of accidents

EH – overall workhours of all workers in 1 year

Industry	Accident rate			
	Total	> 1 lost workday	<= 1 lost workday	Other cases
Flat glass production	19	5,5	5,5	8
Hollow glass production	18	3	6,5	8,5



Risks related to Hot Temperature

Risks related to Glass Cutting

Highly Automated Area

From furnace

IS (Independent Sections) Machine



Hollow glass forming

Heat treatment

Cold treatment

Tiana Mccal4 Multi4

Tiana MX4

Somex

Packaging

Principal Risks

- Burns
- Cuttings





Risks Caused by the Product

In the case of hollow glass production the risks for operators are caused not only by machines and hot intermediate products, but also by finished containers

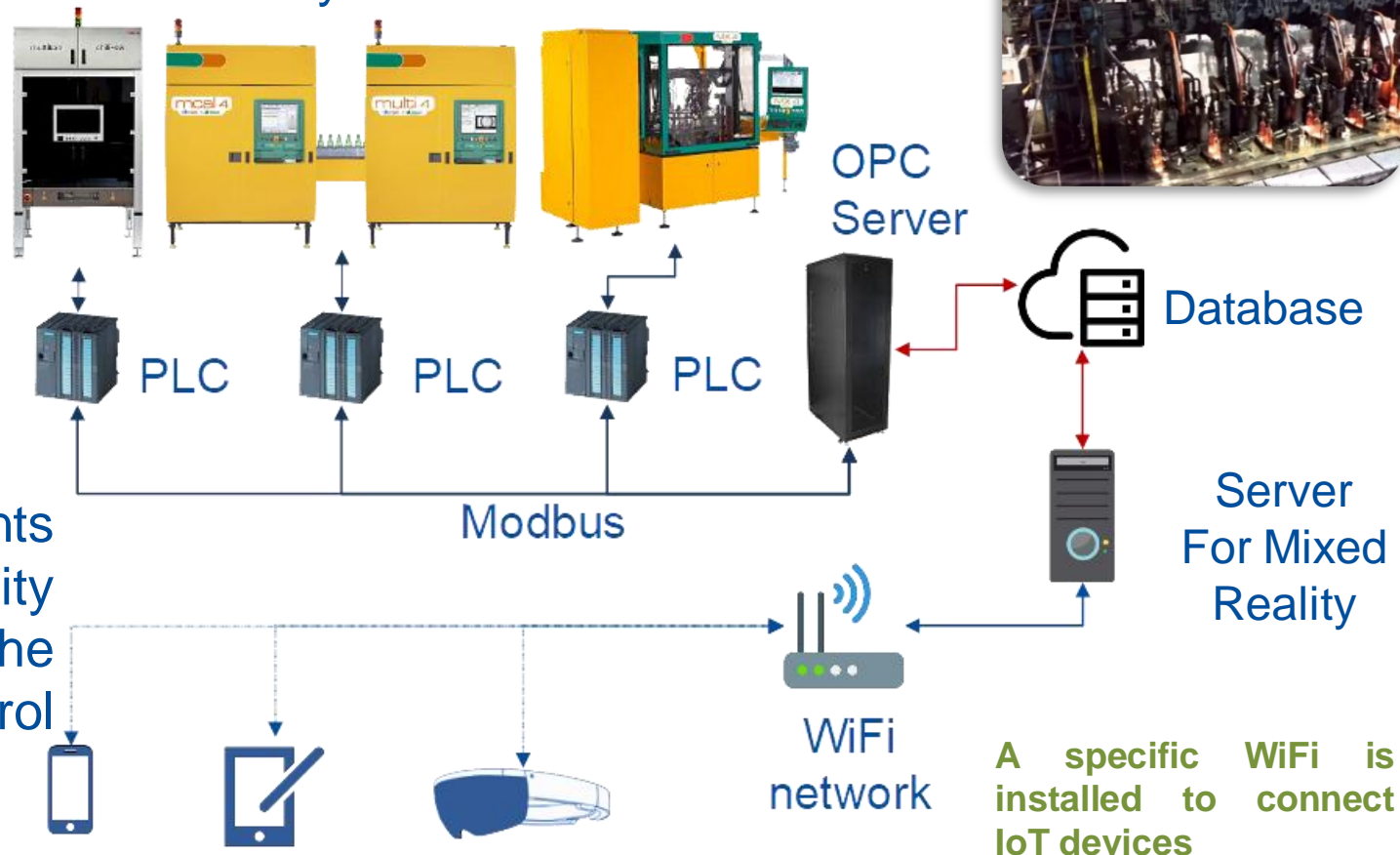


Defective glass containers with cutting edges



System Architecture

Quality Control



The experiments on Mixed Reality focuses on the Quality Control Machines.



Databases & Tables

Table productions

Cod Production	CodLine	DateTime ...	CodProduction Log
AGBT2456	AGBT		CZ_KRLL1784...

Line + N seq.

Table points

Name	Area*	Type	IdPoint
A528881	PL	Calculated	1788
A5210654	PL	Calculated	21
A5210AB	PL	Setted	627

* - possible values: CE, IS, PL, LN, null

Table
CZ_KRLL1784_001_20190605_0211

IdPoint*	IdAcq	Val
1788	181200630	21
21	181200630	5802877
627	181200630	244530

Year + day + hour + minute

Table applgrf01 cfg

CodMnuNode	...	Title
COD_A528881000		Waste 6 external
COD_A5210654000		Total wasted Machine OLT
null		null

Modify names



Currently the machines are capable to provide sufficient about of information regarding their state, however, reports submitted by the personnel are still managed in the *old way*.

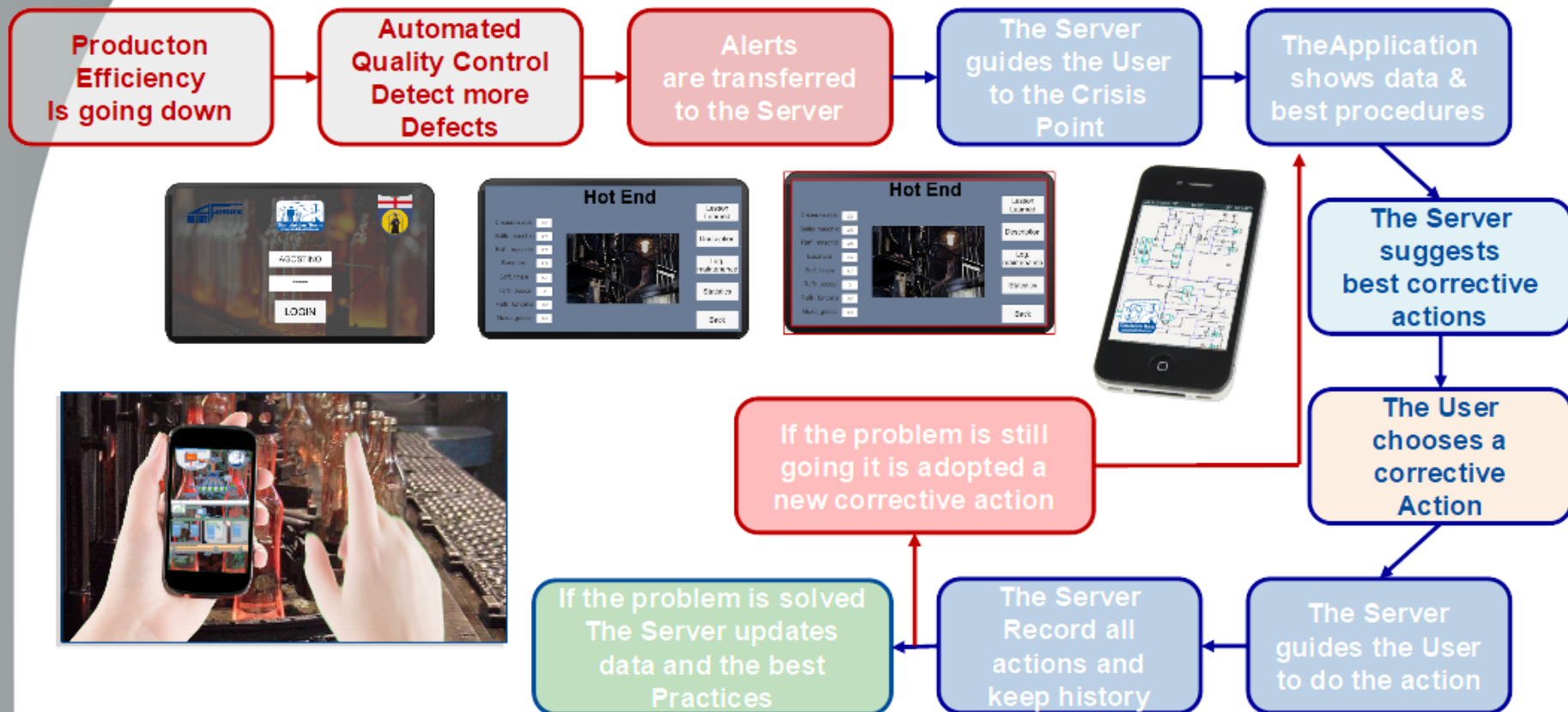
[illegible]

This project includes utilization of interactive feedback system.

These new data are used to support operations of the on-site operators by intelligent systems.



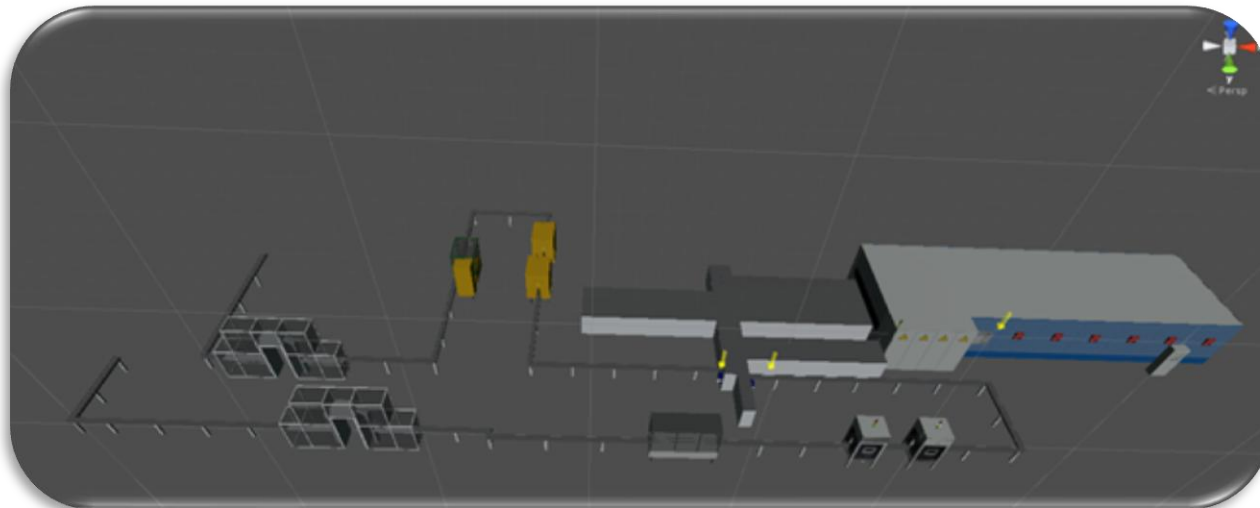
Developed Feedback Procedure





Implementation

The Mixed Reality (MR) application is developed through the Unity 3D cross-platform engine, one of the currently most used software to develop virtual reality / augmented reality applications (VR/AR), capable of generating applications that can be run on different platforms. This design choice has the advantage of being able to write the code only once and then export it quickly across multiple platforms.



Production line layout in Unity Editor

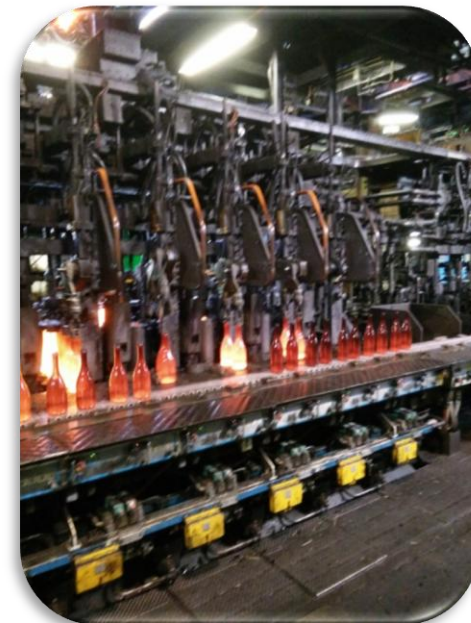


Experimentation

There are different possible use mode for these new systems in industrial plants. One is related to support directly the operators within the plant; in this context AI and wearable technologies help the operator to understand quickly problems and criticalities. Another important use mode is related to the idea to adopt these Mixed Reality Solutions to train operators off line and on line and to improve their familiarity with problem solving and interventions on the productions Lines.



Time variation of KPI of a machine



Independent Sections (IS) machine



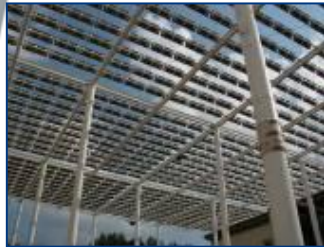
Conclusions



This research focused on modern mobile and wearable technologies and their possible integration with Production Plant. The experience was successful both with new industry 4.0 machines and old components inside different kind of production lines and it was possible to identify synergies with available information systems and to integrate data in modern plants in order to improve safety. The project is in active development phase and experimentation are ongoing; however, Subject Matter Experts (SME) have been involved since the beginning and currently they confirm their interest in these solutions, based on preliminary experimental results.



References



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