INTERACT – Interactive Manual Assembly Operations for the Human-Centered Workplaces of the Future

Grant Agreement Number	:	**611007**
	:	**INTERACT**
Project Start Date	:	**1st October, 2013**
Consortium	:	**DAIMLER AG (DAIMLER)- Project Coordinator**
		ELECTROLUX ITALIA S.P.A. (ELECTROLUX)
		INTRASOFT INTERNATIONAL SA (INTRASOFT)
		IMK AUTOMOTIVE GMBH (IMK)
		EMPHASIS TELEMATICS AE (EMPHASIS)
		HADATAP SP ZOO (HADATAP)
		UNIVERSITY OF PATRAS (LMS)
		UNIVERSITAET ULM (IMI)
		DEUTSCHES FORSCHUNGSZENTRUM FUER KUENSTLICHE INTELLIGENZ GMBH (DFKI)

Title	:	**Deliverable 3.3.3 -** *"Integrated sensor system"*
Reference	:	**D3.3.3 of Task 3.3, WP3**
Availability	:	**Public**
Date	:	**2015-03-31**
Author/s	:	**LMS, EMPHASIS, IMI, HADATAP**
Circulation	:	**Consortium, Public**

Summary:

Deliverable D3.3.3 created in Task 3.3 – *"Integrated sensor system"*

This document describes the integrated sensor system that was implemented during task 3.3 of WP3 for the INTERACT platform. It is the result of the integration between the individual sensors implemented during task 3.2, and the data synthesis and sensor management platform implemented during task 3.3. The integrated sensor system is the main outcome of task 3.3.

Contents

1. INTRODUCTION

The following sections provide the overview of the INTERACT integrated sensor system (ISS) that has been implemented in order to:

1. Provide synthesized sensor data of manual assembly tasks to the INTERACT enterprise

   application platform (EAP)

2. Manage all sensor systems in a centralized way through a management module

The implementation effort was spent on defining interfacing requirements, coordinating developments of the various systems, developed during tasks 3.2 and 3.3, and conducting integration tests by terms of interfacing all systems, in order to achieve the synchronized operation of the individual sensor systems.

The ISS consists of the following:

1. Individual sensor systems that capture data from the developed sensors

2. The sensor management platform (SMP) that implements all sensor management processes and is responsible for the interface between the ISS and the EAP

3. The sensor synthesis method, for the synthesis and synchronization process of the individual sensor systems

Sections 2 to 4 provide a simple description of the above referenced systems and methods and section 5 provides the overview of the ISS.

2. INTERACT SENSOR SYSTEMS

2.1. Optical sensor network

The INTERACT optical network, developed during task 3.2, is responsible for capturing manual assembly tasks using multiple cameras, and fusing the captured videos, in order to provide skeletal tracking data to the INTERACT SMP. The architecture of the optical network is presented in the figure below. Detailed description of the system can be found in D3.2.2.
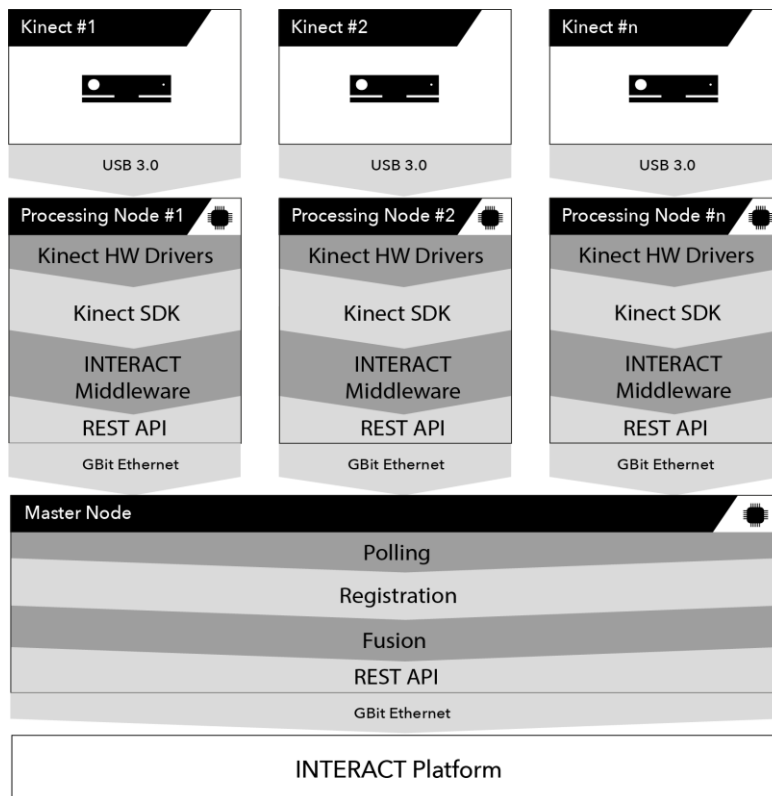

Figure 2.1: INTERACT optical sensor network

2.2. Wireless sensor network (individual sensors)

The INTERACT wireless sensor network (WSNt) has been designed in order to supply additional information in complement to the optical sensing system. It consists of a set of wireless nodes with sensors, that transmit, through ZigBee protocol, the captured data to the wireless sensor base station (WSBS), where it is being cached, in order to be available to the SMP. Detailed description of the system can be found in D3.2.2.
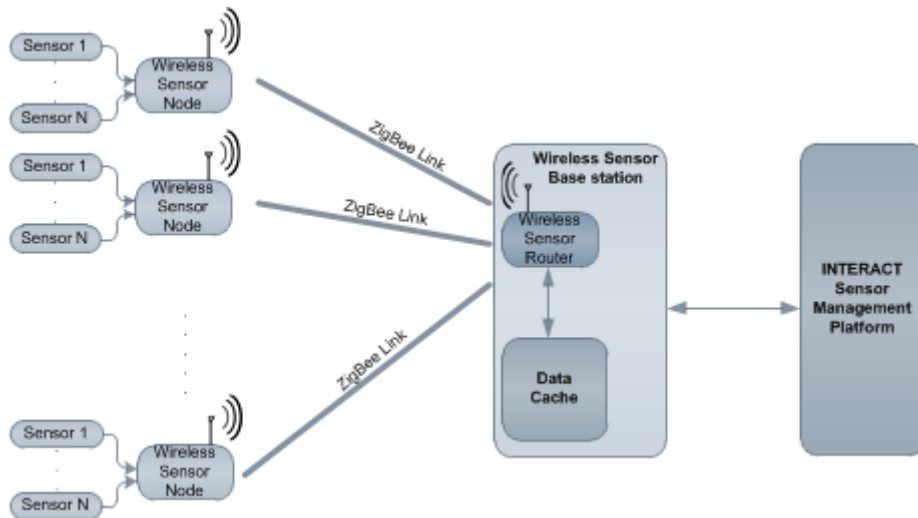
Figure 2.2: INTERACT wireless sensor network

2.3. Tool sensor network

The INTERACT tool sensor network has been designed to supply information about operations performed by tools and to enable tool sensors' configuration. Tools are interconnected through wireless interface with the tool sensor manager, which collects the tool data and forwards them to the SMP. Detailed description of the system can be found in D3.2.2.
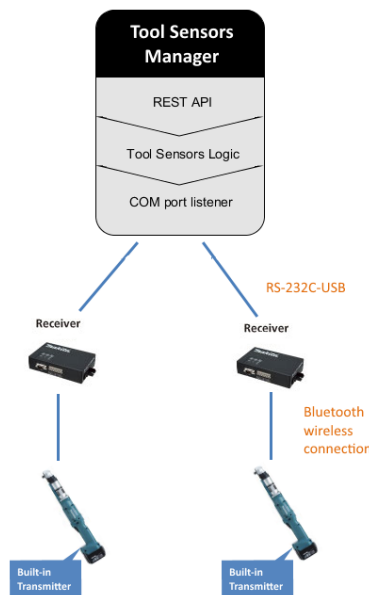

Figure 2.3: INTERACT tool sensor network

3. SENSOR MANAGEMENT PLATFORM

The INTERACT SMP is the administration component of the ISS. The module implements the following functionalities:

- Discovery of available, online sensors

- Data capture (start, stop, retrieve, delete)

- Sensors configuration and calibration

- Sensors raw data monitor

- Save/load platform/sensor configuration

- Time synchronization of the individual sensor systems

The SMP is also responsible for providing the interface between the ISS and the EAP, as a single point of interaction. All operations related requests are transferred to the SMP and from there to the various sensor systems. A detailed description of the SMP can be found in D3.3.2.
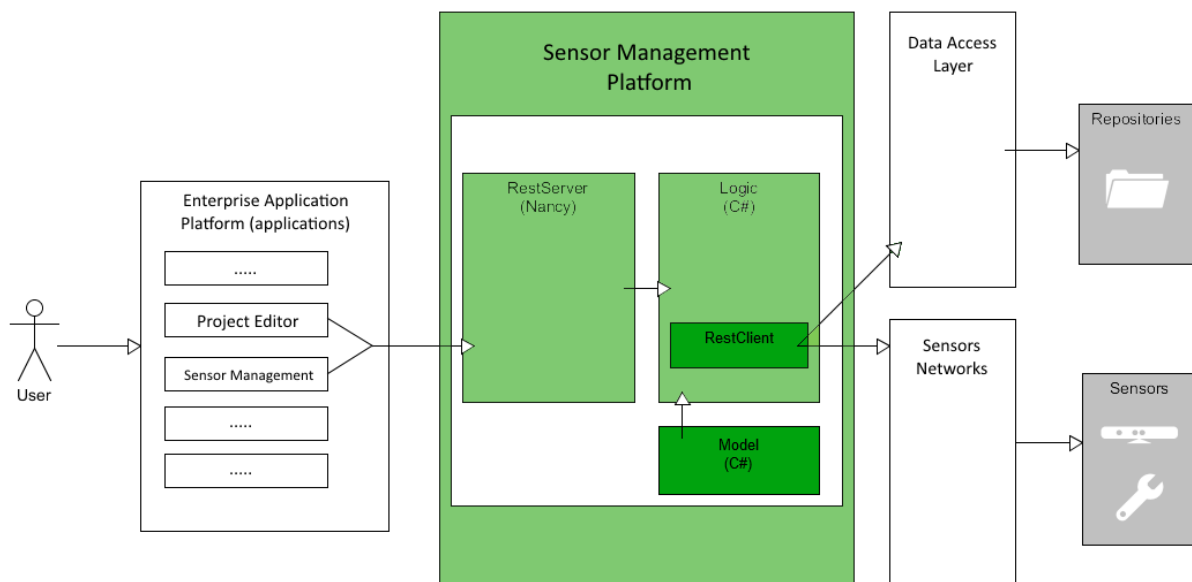
Figure 3.1: INTERACT sensor management platform

4. SENSOR DATA SYNTHESIS

In the current ISS, the various data coming from different sensors are synthesised. For this purpose, a synthesis method has been developed during task 3.3, which implements this task in a two level approach. The first level regards the same type of sensors such as optical, individual or tool sensors and the second one regards all the data managed by the SMP (i.e. all sensor types).

The synthesis on the first level regards the description of the same type of data in a common format. This is done in a straightforward way, when it comes to the individual and tool sensors. However, the optical sensors require additionally the fusion of the data for each skeletal joint using a rating system. The rating system is used to calculate the values of the joints for each frame by rating each joint based on the user's relative position to the optical sensor.

On the second level, synthesis requires the synchronisation of all data (global synchronisation) in order for all sensor data to refer to the same time instances (i.e. reference a common time-frame). Based on a review of existing global synchronisation methods, NTP was considered as the most appropriate.
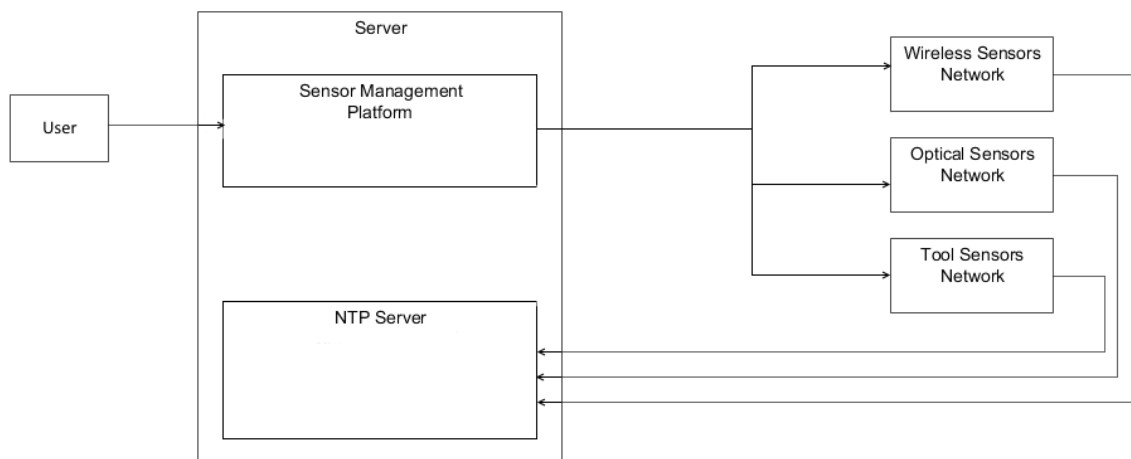

Figure 4.1: INTERACT sensor network time synchronization

The data synthesis method is described in detail in D3.3.1.

5. INTEGRATED SENSOR SYSTEM

All of the above systems and methods form the INTERACT ISS, which performs the following operations:

1. Captures data from all individual sensors that monitor the manual assembly tasks, as referenced in section 2,

2. Performs synthesis, and time synchronization of the captured data from all individual sensors with the use of the NTP based method, as referenced in section 4,

3. Performs configuration and calibration of the individual sensors, as referenced in section 3,

4. Provides interface with the INTERACT EAP for all operations, as referenced in Section 3.

As referenced in section 3, all operation requests from the EAP are being handled by the SMP, which is the only point of interface between the enterprise platform and the sensor system. This provides a robust and controlled interface between the two systems.
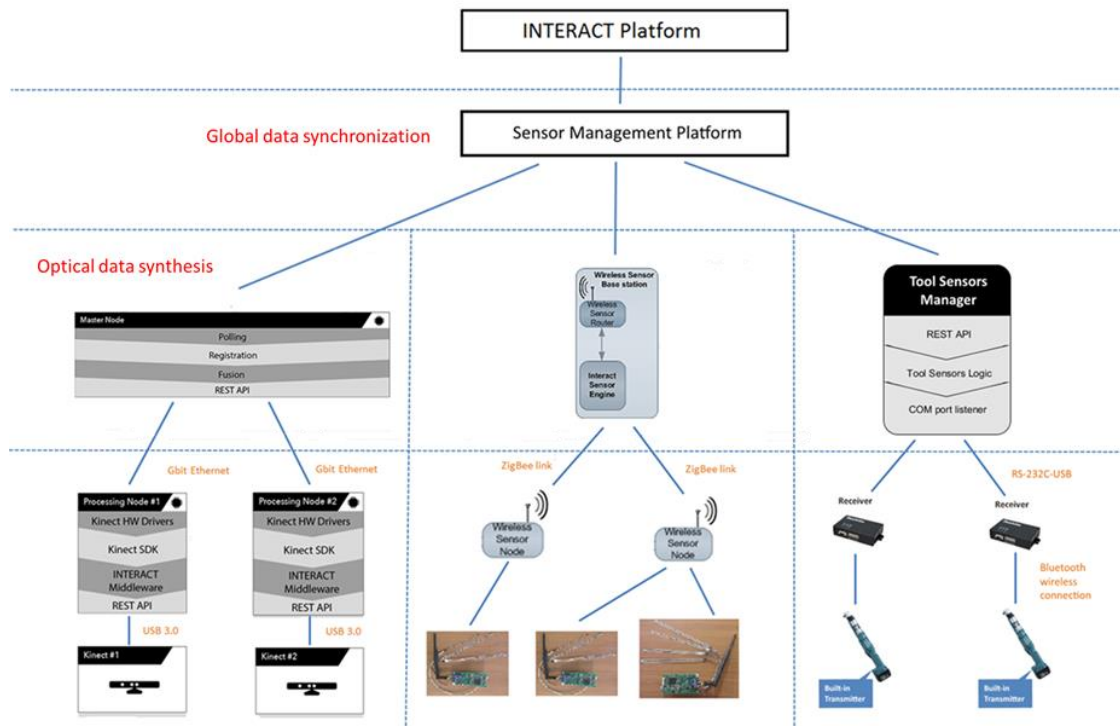

Figure 4.2: Integrated INTERACT sensor system

As stated in section 1, the integration of the sensor system relied on the following tasks:

1. Definition of the integration requirements, which were integrated in the development requirements of tasks 3.2 and 3.3 for the systems described in the previous sections

2. Coordination of the system developments in order to fulfil the integration requirements

3. Testing of the individual systems and methods developed during tasks 3.2 and 3.3 on the integration level according to the requirements

6. SUMMARY AND CONCLUSIONS

The present document describes the INTERACT ISS, as implemented within WP3. It describes the various systems that form the ISS and were developed in tasks 3.2 and 3.3. There are also presented the steps that were taken in order to implement all necessary integration requirements as well as the resulting system, which delivers synchronized sensor data and offers sensor management operations.

The first prototype of the integrated sensor system has been implemented and the next steps are the integration with the EAP and the validation of the system in the INTERACT pilot cases.

ABBREVIATIONS

ISS	Integrated Sensor System
EAP	Enterprise Application Platform
JSON	JavaScript Object Notation
ME	Motion Element
MRSR	Motions Recognition Semantic Repository
OSN	Optical Sensor Network
SMP	Sensors Management Platform
TSN	Tool Sensor Network
WSNt	Wireless Sensor Network
WSBS	Wireless Sensor Base Station