Merging Geospatial Technologies with Cross Reality in the context of smart manufacturing systems

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Background

Over the last few years, disciplines such as Cyber-physical systems, Internet of Things, Geographical Information Systems, Spatial Data Infrastructure, Artificial Intelligence, Virtual, Augmented and Mixed Reality have undergone a profound evolution, essentially driven by the ever-increasing computational power and by the availability of new hardware and software technologies.

In this context, the defense, aerospace, agriculture, health and industrial sectors are experiencing what is known as the "Industry 4.0 Revolution", while Geographical Information Systems and Spatial Data Infrastructure are moving beyond just maps and mapping.

The unprecedented success of 3D Geobrowsers, mostly due to the user-friendliness typical of their interfaces and to the extremely vast set of information available, undoubtedly marked a turning point within the geospatial domain, clearly departing from previous IT solutions in GIS such as composing database queries via 2D graphical interfaces and procedural languages. Nowadays, 3D Tiles are widely used by government and commercial entities for global-scale terrain, city-scale photogrammetry, and massive point clouds from LIDAR. Interoperability, interactivity, and 3D Content Visualization and Creation, and Simulation are five of the most important challenges related to the confluence of digital revolution effecting the industrial and geographical information sectors.

In recent years, research on interoperability has evolved from its roots in the manual exchange of spatial data files into the establishment of standardized spatial data repository

structures, and then finally into novel initiatives in the management of semantic aspects of data. Interoperability is hampered by the need for universal agreement on standards as well as the development of appropriate tools and methods. The Open Geospatial Consortium (OGC) has proposed many such standards with the intention of promoting interoperability through the use of services such as Web Mapping Service (WMS), Web Processing Service (WPS), Web Feature Service (WFS) and Web Coverage Service (WCS). However, there are several persisting issues regarding interactivity, 3D data visualization and simulation, fault tolerance, scalability, server-independent implementation, delayed-time transactions, all clearly indicating a need for further study and discussion.

Geospatial needs to move out of the comfort zone of governmental nourishment and begin to play a role in industry and society. Specifically, there is a need for effective interaction techniques for Geographical Information Systems (GIS) using Cross Reality technologies (VR/AR/MR/XR). Considering the vast amount of information available in modern geodatabases, appropriate visualizations and according multimodal interaction techniques must be developed in order to allow for efficient human sensemaking and analysis of geographic information.

We hope this work will influence both academia and standards development organizations to develop or extend data representations that are able to promote better use of GIS thinking in production environments.

Workshop Description

Nowadays, it is widely acknowledged that geospatial information has immense applicability across a vast spectrum of human endeavors. Examples include oil and gas exploration, energy management, smart city, weather forecasting and tracking, aviation, satellite ground systems, environmental planning, disaster management, public administrations (e-government), civil planning and engineering, and all fields of e-science. All such activities entail gathering significant amount of data and other critical information that must be stored, accessed and managed. This clearly requires novel methodologies and technologies capable to deliver both interactive visualization and intelligent complexity reduction.

The main focus of the workshop will involve the detailed dissection of these technologies, their relationship to one another, and their unique abilities to realize Cross-Reality capabilities and design principles in a multimodal immersive and intelligent geographical environment. The goal is to enumerate (and prioritize) critical re-search and standards opportunities for merging geospatial technologies with smart manufacturing systems.

In the first keynote, **William Z. Bernstein** will began illustrating how the adoption of extended reality (XR) technologies in manufacturing environments continues to grow. However, considering that industrial XR is such a fast-paced, competitive marketplace, technology obsolescence is also a major obstacle for this expansion. These challenges hinder true interoperability of industrial XR systems. Dr. Bernstein presentation will highlight our recent findings as we merge Industry 4.0 (or smart manufacturing) models with well-known standards from the geospatial / location-based service industry.

In the second keynote**, Raffaele de Amicis** will explain how spatial data infrastructure play a fundamental role in the implementation of the 4th Industrial Revolution. Within this scenario, the research community faces the increasing number of large repositories of geospatial data stored in different locations and in various formats. Furthermore, all physical world objects inherently have a geographically-anchored pose, in the third keynote, **Joshua Lieberman** will talk about GeoPose. The web already has a geolocation API, but it is not sufficient for AR purposes: it gives position but not orientation. GeoPose allows any real or virtual objects to be positioned/oriented relative to each other within a user's view or interest area by chaining them ultimately to the same geospatial frame of reference, while allowing for visual/local correction of positioning uncertainties or errors.

The fourth presentation, **Radkowski Rafael** will present how AR relies on accurate maps and to pinpoint the location and object of interest. Dr. Radkowski will introduce a visual indoor positioning system that works with indoor landmarks to identify specific locations, e.g., a workbench, on a map. The talk will motivate the application use cases for a system such as this and further discuss opportunities to leverage GIS data as a navigation graph description.

In the fifth keynote, **Scholz Johannes**, will elaborates on the utilization of Geoinformatics for Smart Manufacturing purposes in a semiconductor manufacturing company. The presentation deals with some necessary fundamentals of Indoor Geography and Geoinformatics and shows a number of use-cases where Geoinformation substantially contributes to Industry 4.0 in a semiconductor company. In the last keynote, **Bruno Sim**ões, will present how the idea of "digital twin" is unfolding as a virtual instance of a physical system (twin) continually updated with the latter's performance and health status data. Consequentially, comparing the digital and physical asset becomes straightforward as the twin model tracks physical assets directly, and indicates divergences from the idealized processes. The presentation will highlight some future research directions to integrate Cross-Reality techniques and Geoinformation to support digital twin for Smart Manufacturing.

Workshop Agenda

Time	Activity	Speaker	Title &Description
20/25 Minutes	Welcome & Introduction	All	The Chairman will present the purpose of workshop, introduce the participants and ask them to identify themselves and their organizations .
20/25 Minutes	Presentation	William Z. (Bill) Bernstein	**Facilitating Interoperability for Industrial XR through Standards:**
20/25 Minutes	Presentation	Raffaele de Amicis	**Interactive Spatial Infrastructures for Industry 4.o**
20/25 Minutes	Presentation	Joshua Lieberman	**The evolution from map skills to reality experiences with GeoPose and related data standards:**

20/25 Minutes	Presentation	Radkowski Rafael	**Visual Indoor Positioning for Workplace Augmented Reality Support.**
20/25 Minutes	Presentation	Scholz Johannes	**Indoor Geography and Geoinformatics for Industry 4.0: Some lessons learned from an Application in the Semiconductor Industry**
20/25 Minutes	Presentation	Bruno Simões	**Geo Platform for Digital twin.**

Workshop Organizers Short Bio

Raffaele De Amicis

Dr. De Amicis is Associate Professor at the School of Electrical Engineering & Computer Science at Oregon State University. He received his Ph.D. in Design and Methods of Industrial Engineering at the Faculty of Engineering, University of Bologna, Italy. From 1999 to 2003, he was a research fellow at the Fraunhofer Institute for Computer Graphics in Darmstadt, Germany and senior researcher at the at the Technical University of Darmstadt. Before arriving at OSU, he was the Managing Director of GraphiTech, Center for Advanced Computer Graphics Technologies in Trento, Italy, where he was recognized for leadership in science, technology, and innovation. He has been the PI for multidisciplinary projects contracted or granted (> $50 million) by the European Commission, NATO, government agencies, and industry. His research includes over 150 scientific publications. Furthermore, he has been the advisor of 7 Ph.D. students, 15 M.S. students, and 26 REU students.

William Z Bernstein short bio.

Dr. William Z. Bernstein is a Mechanical Engineer in the Systems Integration Division at the National Institute of Standards and Technology (NIST). He manages a project on Product Lifecycle Data Exploration and Visualization as part of the Model-Based Enterprise Program. Currently, Dr. Bernstein is developing a new visualization laboratory at NIST to support research into smart manufacturing systems with particular emphasis on deriving actionable knowledge from manufacturing data. He contributes to standards focused on the integration of manufacturing and design knowledge to connect the "digital thread" between these two areas.

Dr. Bernstein's current research interests include Smart Manufacturing, Digital Enterprise, Sustainable Design, Data-driven Manufacturing, Product Lifecycle Management, Visual Analytics, and Information Visualization.

Johannes Scholz short bio.

Dr. Scholz is an Assistant Professor at Graz University of Technology, Institute of Geodesy, Research Group Geoinformation, and member of the Commission Geographic Information Science of the Austrian Academy of Sciences. Previously, He was Associated Faculty at Doctoral College GIScience of University of Salzburg, lecturer at University of Salzburg, Department of Geoinformatics, and lecturer at Alpen-Adria University Klagenfurt/Celovec, Department of Geography.

Dr. Scholz research interests include: Spatial-temporal modeling, (spatial) ontology and semantics (applications utilizing Linked Data paradigm and Digital Humanities), combinatorial optimization in GIS (focus on transport planning), spatial agent-based simulation, modeling indoor space (with applications in Industry 4.0 / Cyber-Physical Systems), land use and land cover modeling.