

Geo-Immersion: A Killer-App for Cloud Computing, Social-Networks and Mobile Computing

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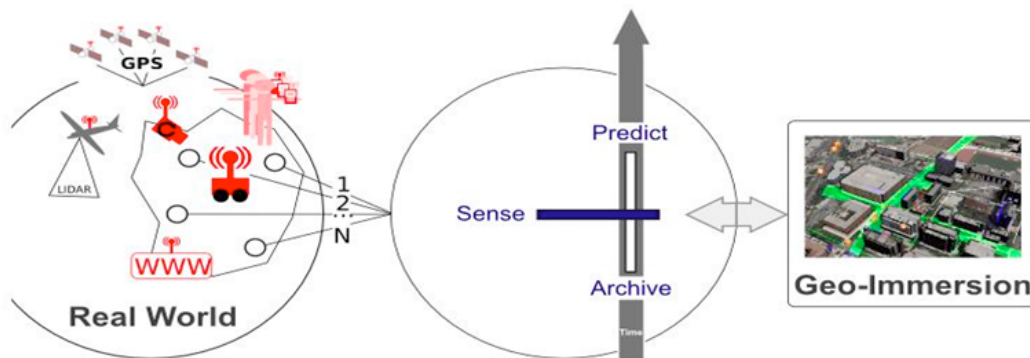
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Since July 2010, at the University of Southern California's (USC) Integrated Media Systems Center (IMSC), a graduated National Science Foundation (NSF) Engineering Research Center (ERC), we have been focusing on a new geo-socio-temporal computing paradigm, termed *Geo-Immersion*. Geo-Immersion enables humans to capture, model and integrate real-world data into a geo-realistic virtual replica of the world for immersive data access, querying and analysis. It encompasses research from many interesting areas including cloud computing, social-networks and mobile computing. To put simply, the main theme of Geo-Immersion is to *blend the real and virtual worlds*.



Geo-Immersion is a much broader concept than that of the previous fields of augmented-reality, virtual-reality, etc. The reason is that the focuses of these past concepts were mainly on the computer-graphics and visualization aspects of Geo-Immersion. However, the more exciting and emerging topics are now the fusion of human behaviors in these two worlds. Hence, Geo-Immersion is more than a research topic and I would go as far as to categorize it as a new *computing paradigm*. Let me elaborate.

The main task of the first generation of computers was “computation”, for example, computing differential equations. This changed in late 1960's with the advent of ARPANET's university network where the task of “communication” was added to the major tasks of computers. In fact, computers were still performing computation in order to enable communication, but computing went to the background for the seamless support of the new task. The third generation computers, in early 1990's, enabled “information access” through the Web. This time, communication took the backseat in support of information-access.

I believe that the next-generation of computers will be tasked to blend the real world with the virtual world, i.e., Geo-Immersion. We already witness this through the excitements over location-based-services, social-networks, participatory-sensing (crowdsourcing), and cloud computing. This new paradigm uses the four dimensions of *what, when, where and who*, which enable people to naturally operate in a hybrid virtual-real world. After all, human brain is wired to

operate in time and space. For example, I am obsessed with planning my future based on where and when. Then why not use the same concepts in the virtual world to both operate more naturally (by transparently accessing information, communicating and computing) and better integrate the real-world data, phenomena and observations into the virtual world.

To illustrate my point and also the relationship of Geo-Immersion with the topics of this workshop, consider two prominent uses of computers by public: social networking and mobile-apps (e.g., on smart-phones or tablets). I consider social networking as bringing the *real* world and its social fabric to the *virtual* world. Meanwhile, mobile-apps bring the *virtual* world and its efficiency and flexibility to the *real* world. This is the fusion envisioned by Geo-Immersion.

The applications of Geo-Immersion are plenty: urban security, disaster management and rescue-response, military intelligence, urban planning and real-estate, intelligent transportation, simulation and training, public health in urban area, sustainable design, etc. At IMSC, we have been working on some of these applications. To further illustrate the concept and its relationship to this workshop, I briefly explain our work in intelligent transportation.

In the past two years, as part of IMSC's contract with Los Angeles Metropolitan Transportation Authority (MTA), we have been given access to a very large-scale and high-resolution (both spatial and temporal) transportation data from LA County road network. This dataset includes traffic flows recorded by under-pavement loop detectors, police reports, videos and images from CCTV cameras, and operational public transit data such as passenger counts and buses' locations. We have **virtualized** these **real world** datasets by developing an end-to-end system called *TransDec* (for Transportation Decision-making). The backend of TransDec is a **cloud platform**; in particular, all the data (except for videos) are saved to Microsoft Azure storage space. In order to allow processing of queries on such a large data set efficiently, the data is aggregated to create sketches for supporting predefined set of spatial and temporal queries. A Microsoft StreamInsight server, which resides on the Azure AppFabric, handles this aggregation process. The sketches are then written to SQLAzure. Other than infrastructural benefits, this eliminates communication and data-transfer costs to a cloud storage platform. The collection, its refinement, and required geostreaming queries of the traffic data are also implemented on Microsoft's StreamInsight. In other projects, we showed that other relevant datasets (e.g., accidents, traffic reports) can also be contributed by people using their smart phones and through their **social-networks**. Finally, the front-end of TransDec is a mash-up (developed on both Microsoft Bing and Google Map) that is accessible through desktop and **mobile platforms**. For example, we are developing a next-generation route-planning application for smart-phones dubbed ClearPath. ClearPath can quickly find the fastest way to get from Point A to Point B, by taking real-time and future traffic congestion into consideration. ClearPath will save commuters time and money, and make delivery businesses more efficient.

In conclusion, I believe blending the real and virtual worlds through Geo-Immersion, is a killer application for cloud computing, social-networks and mobile computing. It is a new computing paradigm that dominates the way the public utilizes computers in recent years (through their mobile apps and social networks) and has many useful real world applications. It also encompasses research from many interesting areas such as multimedia, participatory-sensing, privacy, trust, web, geospatial and temporal data management, etc. But more importantly, it brings up new fundamental research challenges in computer and social sciences to study the fusion of human behaviors in the real and virtual worlds. For example, how would one blends social-networks (represented as a graph) with geospatial (represented as 2D or 3D space) and temporal (represented as points or intervals) spaces? Is it possible to derive social-networks by analyzing people's movements in time and space? At IMSC, we have just started scratching the surface of this transformative paradigm. But above all, this paradigm enables people to "connect" across time and space. Isn't this what humanity is all about after all?