Spatial Technology and Social Media in Remote Sensing: Challenges and Opportunities

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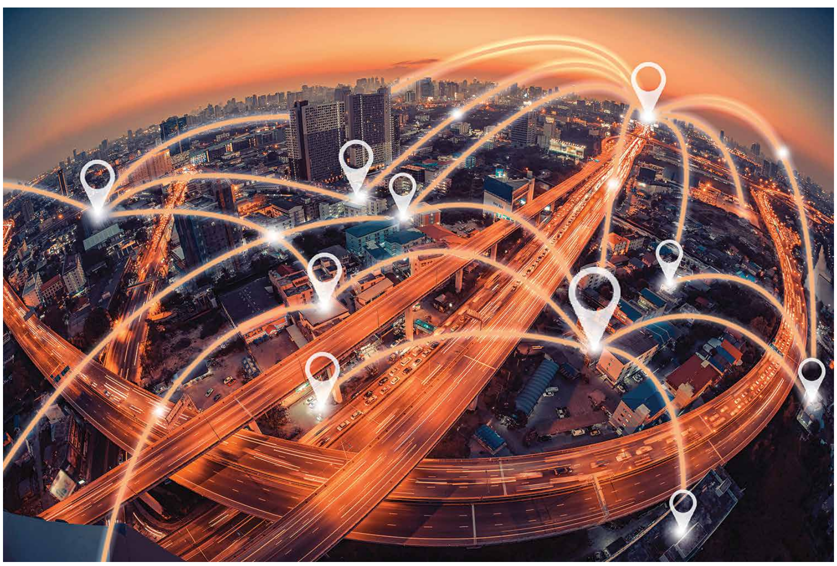

The convergence of remote sensing technologies with social media, coupled with advances in other location-aware technologies such as WiFi and smartphones, is moving us on a fast track to a situation in which we can readily know, at any time, where everybody and everything are located on the surface of the Earth, and to exploit the power of social media in different contexts. Remote sensing technology involves the use of systems and algorithms to record information about the surface of the Earth from a remote location [1]. Although reliable as a data source, remote sensing data may not always be available. However, these data can be complemented by other sources of data, such as geographic information systems (GIS) and social media [2], in order to address time-critical applications. For instance, relating publicly available social media information with remote sensing or GIS data can lead to a more efficient management of emergency response (which refers to applications in which real/near-real-time response is needed, such as natural disasters). Social media are now playing a more relevant role in our daily lives and provide a unique opportunity to gain valuable insight

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on information flow and social networking within the society. As a result, the integration of social media data with other consolidated technologies such as remote sensing or GIS is of great importance.

The impressive development in social media technologies over recent years is now being complemented by the emergent use of spatial technologies. This results in a capacity to provide new mapping mechanisms that allow users to easily engage with online information services in new ways. For instance, successful examples exist in which techniques with adaptive localization exploit picture-oriented social networks such as Instagram to detect urban events, exploiting physical proximity embedded in the social network data and temporal and location data in photos. Image sharing services allow users to include their latitude–longitude coordinates to photograph instances (positioning), which means that location information can be now considered in online social networks [3]. These "footprints," which can be also easily associated with Earth observation data coming from satellites and GIS, provide a growing amount of geolocation information. For example, remote sensing data have been successfully combined with information coming from social media and spatial mapping services in order to monitor the impact of natural disasters [4]. After a disaster, response teams commonly use satellite imagery, but the images may not always be available in a timely manner. As a result, there has been a growing interest in the use of social media data to complement the information available from satellite images. Some applications in which the fusion of data from remote sensing and social media has already found success include earthquake detection from Twitter and Facebook information flows [5], use of Twitter data to complement satellite images in order to identify additional flooded areas other than those found with satellite images [6], integration of remote sensing and social media data to study human movements across several metropolitan areas (focusing mainly on short term movements and revealing that the probability of a friendship between two individuals is inversely proportional to the number of friends between them, and depends only indirectly on physical distance) [7], or the analysis of air-pollution-related posts in social networks in order to integrate such information with real sensor feeds [8]. In fact, the increase in the volume, velocity, and variety of data that needs to be managed in these and other related applications contributed to the definition of the term "big data" [9]. This data avalanche also requires advanced data mining and processing techniques such as machine learning approaches [10], coupled with adequate high-performance computing infrastructure, in order to be successfully exploited.

Although important progress has been made in recent years in the task of harvesting spatial and temporal data from social media [11], the fusion of multiple data sources for decision making still needs further investigation, particularly in the context of the integration of social media with remote sensing and GIS data. In other words, it is needed to explore new ways in which such fusion can be deployed to promote the human-as-sensor paradigm [12]. This has the potential to introduce important new applications resulting from the integration of social media information and remote-sensing-based spatial technologies. As mentioned above, relating publicly available social media information with remote sensing data can lead to a more efficient response to disasters. However, the specific technical challenges related to mining social media data often represent a hurdle for the achievement of such a goal. First and foremost, the massive amount of information available in social networks (the inherently linked nature of social media data) complicates the information extraction task. Another important concern is the need for accurate techniques for data analytics that can be efficiently executed in large-scale high-performance computing infrastructures. Making estimations using questionable data is also a concern, and challenges may arise from a lack of computational understanding or distrust with social media data. Finally, information intended to deceive can spread through social media in the same way as valid information. This raises questions of how to detect different types of deception. For instance, after acknowledging that it has a problem with fake news, Facebook recently introduced a feature that flags certain posts as "disputed."

In summary, the increasing ubiquity of location-based social media, and their integration with other sources of information such as remote sensing and GIS, has the potential to provide the basis for new geosocial information systems. Accomplishing this will require new methods, new algorithms, new systems, and (particularly) new big data processing frameworks, able to fuse, mine, and analyze vast amounts of data including very high-resolution satellite imagery [13] and spatiotemporal footprints [14]. This line of research is expected to introduce major breakthroughs in upcoming years, mainly due to the growing interest in spatial technologies, social media, and computational/data-intensive approaches [15], [16]. The upcoming Special Issue of the Proceedings of the IEEE on Spatial Technology and Social Media intends to provide a snapshot of the most recent advances and breakthroughs in the aforementioned research areas, with particular focus on the combination of remote sensing data and information coming from social media and GIS, under a big data processing framework. ■

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