social media, smartphones, mobile applications, video content, storytelling, networking

Social Computing

Social Telemedia: The Relationship between Social Information and Networked Media

Omar Niamut, TNO

Mu Mu, The University of Northampton

Spyros Denazis, University of Patras

Nicholas Race, Lancaster University

Allowing users to capture live events collaboratively on mobile devices and share their stories with communities

With the growing popularity of social media sites, online video services, and smartphones, content consumers are recording, editing, and broadcasting their own stories. Social media sites have evolved from text and photo streams to a rich medium for sharing audiovisual content. More and more users are capturing and sharing video content, which can largely be attributed to the increased availability of video-recording capabilities on consumer devices such as smartphones and their integration with online content-sharing platforms. Amateur video capturing has also evolved from a personal hobby to citizen journalism.

New crowdsourced live mobile streaming applications, such as Meerkat (http://meerkatapp.co) and Periscope (www.periscope.tv), have seen an explosive growth in popularity in the past few years.[1] We refer to this community-centric, digitally based ecosystem as *social telemedia*, defined as a cross-breeding of social networks and networked media. Social telemedia enhances current societal practices and habits, such as sharing experiences on social networks through photos and videos , and flourishes on networked middleware frameworks and systems that efficiently combine social informatics and content delivery. Social informatics loosely refers to any digitized information that's generated or exchanged in the context of social networking, and content delivery is the communication medium through which social informatics are exchanged. Examples of social informatics are social relationships in peer-to-peer (P2P) systems,[2] content delivery powered by context and user intelligence,[3] and context-aware networking and communications.[4]

Social Telemedia Applications

Social telemedia systems leverage social media and advanced networking technologies to enable novel applications and new user experiences. Capturing live video footages,

sharing highlights, and circulating narrations have become an important part of the user activities in live social events. Exchanging amateur video recordings with unique personal perspectives elicit more vibrant and immersive community experiences. A social telemedia application identifies and assembles media content produced by event participants or automated systems from various relevant sources. Such creations are then distributed to wider audiences with the help of smart tools and networking infrastructures.

The resultant content, ranging from video clips recorded on personal cameras (with audio and superimposed comments) to segments of live TV broadcast programs, can be organized by their producers or any third-party amateur storytellers to form multifaceted stories or commentaries for immediate or delayed consumption by individuals and communities. Some communities might have previously expressed an interest in or were notified in real time of the event directly or through personalized notification and recommendation systems. We developed STEER, a Social Telemedia Environment for Experimental Research; as part of this environment, examples of social telemedia applications Collaborative Storytelling and Live Augmented Broadcast. The STEER system and the example applications are depicted in Figure 1. The mobile app allows users to capture video for asynchronous storytelling, and to stream user-generated live video to augment professional TV broadcasting of the same event.

Figure 1. Graphical depiction of the STEER system.

Collaborative Storytelling

The Collaborative Storytelling application enables communities to collaboratively author and edit video narratives of a live social event.[5,6] Figure 2 provides an overview of the application and the underlying system components of the STEER system . A Web portal and a mobile application provide the user-facing elements including video capture, sharing, searching, and story authoring. The user applications also capture live metadata such as location information, which is used to provide personalized media experiences. The multimedia processing function encompasses operations such as transcoding, chunking, content analysis, and indexing so that user-generated content can be better shared and discovered. The story-authoring engine uses a unique and lightweight “edit by reference” design to enable collaborative online story editing. It uses edit-decision lists to define time-addressable references of user-generated content so that user stories can be made by manipulating hierarchical references to static video objects without any complex video rendering. The social-context integration function monitors related events and trends on social media sites to improve the user experience in tagging user creations and to discover shared stories related to nearby trending topics.

Figure 2. Collaborative Storytelling application.

Live Augmented Broadcast

Figure 3 shows an application for Live Augmented Broadcast, which combines professional broadcasts of live events with live user-generated content from mobile

devices.[7] Event participants make live recordings with mobile devices, which can be streamed and watched in sync with live broadcasts by viewers at home. An analysis of social network messages is performed to retrieve and show the most relevant posts in sync with a video. By providing additional event-related social and video content, viewers can enjoy an augmented view of live events. Using a common clock synchronized via Network Time Protocol (NTP) results in timeline alignment between mobile streams, broadcast streams, and social content. P2P delivery is employed for efficient delivery of synchronized video streams.[8]

Figure 3. Live Augmented Broadcast application.

Networking Technologies

The STEER system and the related social telemedia applications leverage the following social media and advanced networking technologies.

Adaptive Event Profiler

With the Adaptive Event Profiler (AEP),[9] one can follow news connected to an event on social media sites such as Facebook and Twitter. The profiler allows for emerging-event detection through event tracking on social media, and for personalization through ranking and clustering social media posts. Use cases include suggesting related terms to an event for tagging videos, following social media messages around an event in real time, and creating a social media dataset about a topic. The AEP also allows the retrieval of social media data in a significantly higher volume and degree of accuracy than simply following a single keyword.

The AEP, shown in Figure 4, runs as a Web service on any cloud environment and uses Twitter as a source of textual content to find related keywords. It retrieves significantly more interesting and relevant Tweets than following a single keyword, without introducing too much noise in the dataset. The API allows users to list all events, create and stop events, check event details, and open specific Twitter streams.

During public events, tweets are continually posted with information such as news about the participants and event outcomes. Facebook event pages can be tracked and images posted on an event page can be retrieved and shown in the LAB application.

Figure 4. Adaptive Event Profiler (AEP), an innovative state-of-the-art social media analysis platform.

Media Asset Referencing System

One unique feature of the STEER system, designed to enable asynchronous storytelling, is the “edit by reference” feature. Instead of physically editing and rendering a video object, which consumes computational and network resources for every edit, a story can be composed by creating a list of references to existing video objects. This feature, called the Media Asset Referencing System (MARS), is a media management system that recognizes time-addressable media assets within chunked media objects and generates

new media objects on the fly by combining only the segments that represent time periods that fall within or overlap with those assets. MARS's core is the management of edit-decision lists (EDLs), script-based expressions of a media object's composition. MARS creates a time-addressable descriptive view on the internal structure of media objects using frame-accurate presentation and timecode navigation, so that virtual operations visually assisted by keyframes such as cut and fast-forward can be carried out without having to physically examine the corresponding media objects.

Hybrid media synchronization

Media synchronization technologies for live event coverage enables the seamless combination of professional broadcast and amateur videos shot by the crowd, as well as synchronization with social media feeds such as Twitter and Facebook streams. In the Live Augmented Broadcast application, all media is time-synchronized, recreating an immersive user experience. Content can be ingested by a local node or in the cloud. Ingest nodes work together to achieve frame-accurate media timestamping. In other words, all media sources can insert timestamps in the captured media streams using common synchronized clocks. Frame-accurate synchronized playback is achieved by using these timestamps.

Experiments

Social telemedia applications provide users with novel and exciting opportunities to capture live events on mobile devices and share their stories with communities. We demonstrated the feasibility of the example social telemedia applications and the underlying STEER system through several experiments.

2014 World Rowing Championships

During the 2014 World Rowing Championships in Amsterdam, we assessed the Live Augmented Broadcast application with a focus on crowdsourced live mobile video streaming over 4G and synchronizing user-generated video with professional broadcasts (see Figure 5). We recorded content from a number of different positions around the venue to obtain real-world results. We found that it's quite difficult to create user-generated recordings that appeal to a broad audience. For example, the crowd is only of interest during key moments, and other scenes are typically not related to the event. Added value mostly occurs in the cases of limited professional coverage, clear social context, and for crowd-sourced mobile journalism.

Figure 5. Live Augmented Broadcast application showing synchronized video and Twitter feed.

2014 Winter Olympics

During the 2014 Winter Olympics in Russia, we assessed the interest in and relevancy of social media posts on Twitter during a live TV broadcast. The AEP retrieved and filtered selected Tweets during a series of live broadcasts of figure skating events. These Tweets

were typically generated by TV viewers all of the world, already combining their TV experience with their online social network usage. The experiment considered a number of research questions:

- How can we design an event profiler that generates a set of query terms to retrieve relevant and interesting tweets during an event?
- How does the event profiler perform in generating relevant and interesting tweets, compared to a traditional tool based on a simple event hashtag?
- What is the relation between relevancy of and interest in tweets, also depending on the event profiler settings?

During the experiment, two sessions with 10 participants took place at two different locations. All participants watched a live broadcast of men's 10,000 m (session A) and women's 5,000 m (session B) speed skating finals, with approximately 25 minutes of viewing time. Tweets shown to the participants were evaluated on a seven-point Likert scale for interest and relevancy.

Participants, when shown each Tweet, gave feedback on whether they found it interesting and relevant to the event by clicking a green or red button (see Figure 6). The main keyword to start the profiler was #os2014, the hashtag promoted by the television broadcaster NOS. A list of keywords generated by the event profiler was updated every 5 minutes. We found that the event profiler retrieved significantly more likeable and interesting tweets compared with results from following a single keyword, without introducing too much noise.

Interestingly, relevant tweets aren't necessarily interesting, but interesting tweets are usually relevant.

Figure 6. AEP experiments during the 2014 Winter Olympics.

2014 Silverstone Formula 1 Grand Prix

A third experiment was held during the Formula 1 British Grand Prix racing event on 6 July 2014 in England. We selected two groups of members of the public as participants. Both groups used the storytelling applications of the STEER system extensively to capture the highlights of their Silverstone experience. The amount of data submitted by the groups suggests that participants of live events are very likely to capture a large amount of audiovisual content (not only still images) for personal archiving or social sharing, especially when a group of friends or family travel together.

The videos uploaded by the user community covered the entire trip to Silverstone. We noticed that only a small portion of the videos were about the actual race, while most others were related to other parts of the Silverstone experience, including traveling, camping, and auxiliary entertainment.

We analyze social media and leverage the deep understanding of community activities to improve the user experience of STEER system. proved to be effective in improving video annotation and enhancing the search function during the experiments. Using AEP to recognize trending events ideally solves the "cold start" problem in

content recommendation, when a system does not have any prior knowledge of the user's preferences. Given user location, the STEER system is able to suggest a number of popular user stories related to socially trending keywords nearby. The main keyword used as input for the AEP in this case was "Silverstone." Event and participant names (such as #britishgp and Hamilton) were among the most popular suggestions during the event. For the enhanced search function, the AEP provided a list of related keywords and a metric to quantify the relevance to the search request.

Figure 7 shows a heatmap of related terms in a social network generated from data output by the AEP on race day (6 July 2014). The darker the episode of the related keyword, the higher its relevance to the keyword "Silverstone." This illustrates how hot topics related to live events shared on social media evolve over time as influenced by how the event develops. For instance, #pinkforpapa, a story about the British race car driver Jenson Button and his father, was a trending topic prior to the race (http://en.espn.co.uk/f1/motorsport/story/164969.html). This demonstrates how AEP identifies social discussions on background stories of an event. The hotness of the term "kimi" in the heatmap reflects our observations that the crash on the first lap (by driver Kimi Raikkonen) quickly became a trending topic on social media but didn't last later in the race when topics changed to specific battles and the winner of the race ("hamilton," "#teamlh," and so on). The related keywords were effective in helping participants discover and create personal stories in the STEER system.

Figure 7. Heatmap of related social media terms on the Silverstone Formula 1 race day.

Through our research and experiments, we witnessed the unique role of user creativity in the development cycle of creating and sharing engaging social stories. Furthermore, we found that social context derived from social media, location-based services, and emerging mobile technologies can also greatly improve the story capturing and authoring process. Although automated social storytelling systems are becoming more prevalent, human-level insights, perception, and creativity can't be replaced by a computer algorithm. Rather, humans will continue to be an active and catalytic force in eliciting immersive community experiences. With the rise of network virtualization, the Internet of Things, and emerging wireless technologies, we envision more synergic actions among social media, networking, and machine learning.

References

1. F. Chen et al., "Cloud-Assisted Live Streaming for Crowdsourced Multimedia Content," *IEEE Trans. Multimedia*, vol. 17, no. 9, 2015, pp. 1471–1483.

2. H. Wang, F. Wang, and J. Liu, "Torrents on Twitter: Explore Long-Term Social Relationships in Peer-to-Peer Systems," *IEEE Trans. Network and Service Management*, vol. 10, no. 1, 2012, pp. 95–104.

3. Z. Wang et al., "CPCDN: Content Delivery Powered by Context and User Intelligence," *IEEE Trans. Multimedia*, vol. 17, no. 1, 2014, pp. 92–103.

4. J. Wu et al., "Context-aware Networking and Communications: Part 1," *IEEE Comm. Magazine*, vol. 52, no. 6, 2014, pp. 14–15.

5. M. Mu et al., "Storisphere: From TV Watching to Community Story Telling," *IEEE Comm. Magazine*, vol. 51, no. 8, 2013, pp. 112–119.

6. M. Mu et al., "'Let's Share a Story': Socially Enhanced Multimedia Storytelling," *IEEE MultiMedia*, vol. 22, no. 3, 2015, pp. 54–65.

7. H. Stokking et al., "Augmenting a TV Broadcast with Synchronised User Generated Video and Relevant Social Network Content," *Proc. ACM Int'l Conf. Interactive Experiences for TV and Online Video* (TVX 14), 2014; http://repository.tudelft.nl/view/tno/uuid%3Aa4ad12df-2e12-488d-9a79-cf19c72a9951.

8. M. Efthymiopoulou et al., "Scalable Playback Rate Control in P2P Live Streaming Systems," *Peer-to Peer Networking and Applications,* Springer, 2015; doi: 10.1007/s12083-015-0403-6.

9. R. Kaptein et al., "Retrieving Relevant and Interesting Tweets During Live Television Broadcasts," *Current Trends in Web Engineering,* LNCS 9396, Springer, pp. 175–185.

Omar Niamut *is a senior research scientist at TNO. Contact him at omar.niamut@tno.nl.*

Mu Mu *is an assistant professor in the Department of Computing and Immersive Technologies at the University of Northampton. Contact him at mu.mu@northampton.ac.uk.*

Spyros Denazis *is an associate professor in the Department of Electrical and Computer Engineering at the University of Patras. Contact him at sdena@upatras.gr.*

Nicholas Race *is a Reader in the School of Computing and Communications at Lancaster University. Contact him at n.race@lancaster.ac.uk.*