CoTable: Collaborative Social Media Analysis with Multi-Touch Tables

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ABSTRACT

To be able to take efficient measures in crisis management, it is essential for emergency services to get as much details about an actual situation on-site as possible. Currently content from social media plays an important role since those platforms are used to spread crisis-relevant data within the population. Our contribution presents a concept which supports the situation assessment practices of emergency services by collaboratively evaluating and by analyzing citizen-generated content from social media using a multi-touch table. The concept was implemented based on a Microsoft PixelSense and evaluated with 14 participants. The results reveal the impact of subjectivity of the participants, their positioning around the table as well as the uniqueness of social media posts on the collaborative situation assessment with multi-touch tables.

Keywords

Social media, multi-touch tables, collaboration, CSCW

INTRODUCTION

Within the current response to disaster events, such as the typhoon Haiyan in November 2013 or the hurricane Sandy in October 2012, a variety of actors like police or fire services, private services, national and international aid organizations as well as operators of critical infrastructure are involved. For the purpose of decision-making as well as coordinating and executing operations, information is one of the most valuable resource (Marino et al., 2012), since it is nearly impossible to response appropriately without having any knowledge about the actual situation. Within emergencies, the fast supply of information is a big challenge for the various actors due to its non-transparency and major uncertainty regarding the occurred events (Friberg et al., 2011). Emergencies of recent years show that besides the formal response of professional emergency services, an informal response conducted by affected citizens on-site and other citizens characterized by situational altruism (Dynes, 1994) can be observed. Individuals emerge and form temporary organizations improvising emergency response and relief activities (Wachtendorf & Kendra, 2006). Although such citizen-initiated activities have been always existed within crisis response work, social media and mobile devices have changed the way of communicating before, during and after emergencies (Heverin & Zach, 2010). By using Twitter or Facebook citizens actively provide extensive information about the situation on-site (Palen & Liu, 2007). Furthermore social media is used for information searching (Starbird et al., 2012), coordinating self-initiated response measures (Reuter et al., 2013), and constructing up-to-date situation overview based on official and unofficial sources (Qu et al., 2009).

Although current response practices of emergency services in Germany work well, the personnel capacities can reach its limits in the case of large-scale events. As a consequence, some measures cannot be taken as fast as it would be necessary. Local citizens can be a valuable information source for emergency services to obtain highly up-to-date contextual information or knowledge about geographical or cultural specifics (Starbird et al., 2012). For assessing the current situation, emergency services need to have a picture of the actual situation on-site as precise as possible, which is mainly based on citizen-generated information available for real-time evaluation. In contrast, the enormous flood of information from social media, which is being exchanged during large-scale disasters, has to be dealt with. For emergency services the question arise, how they can integrate the content from social media into their situation assessment and, at the same time, differentiate between relevant and less relevant information.

Within this paper, we will first outline the relevance of citizen-generated information for emergency response work and how current ICT approaches support its integration into official work practices. Building on that, we

will present the motivation and concepts for supporting collaborative work practices with multi-touch tables. Based on those approaches we have developed a concept, which aims to support the collaborative assessment of an emergency situation by using social media content. Furthermore, we have implemented the application CoTable and evaluated it with regard to its usability and applicability.

CITIZEN-GENERATED CONTENT IN CRISIS MANAGEMENT

Often, affected citizens are the first at an incident's location and have therefore an advantage of information and serve as a reliable source for the emergency services to provide up-to-date crisis-relevant information from the ground. Such information allows control centers to assess the situation more precisely at an early point of time. Moreover, local citizens often take initiative and actively participate as spontaneous helpers (Quarantelli, 1984). As part of the Web 2.0, citizens make use of Internet services during emergencies to keep their family and friends informed about their status and to communicate with their neighborhood (Reuter et al., 2012). Already after the 9/11 attacks in 2001 citizens created wikis to collect data about missing persons (Palen & Liu, 2007). Studies show that microblogging-services are utilized during disasters to collect as well as disribute information and to process requests for help (Starbird & Palen, 2011). Twitter serves as a source for situational updates and coordinating actions (Vieweg et al., 2010). Additionally, social media provide space to exchange opinions and to emotionally cope with a crisis (Qu et al., 2011). The response to the attacks in Boston 2013 clearly indicate that social media are suitable to organize relief activitites for the injured or to provide data about emergency shelters. Existing social media have the advantage that its functionalities do not have to be newly learnt durings emergencies and already comprise a network of people (Palen & Vieweg, 2008). There are already existing approaches for analyzing and evaluating of social media content within crisis management:

- *Twitris* (Jadhav et al., 2009) is a platform for monitoring Twitter in real-time. Besides the most popular hashtags, Twitris shows articles and Wikipedia entries regarding search keywords as well as linked pictures and videos. The popular hashtags are additionally displayed in a Linked Open Data (LOD) cloud.
- *Tweak the Tweet* (Starbird & Stamberger, 2010) is a prescriptive system based on Twitter hashtags. The syntax recommends the user to phrase a tweet in a machine-readable structure and enables the rapid detection of those tweets which are relevant to the users' current context.
- *Semsor* (Heim et al., 2011) supports the situation assessment with support of social media analyses. It constantly observes social media such as Twitter, Flickr, or YouTube. Similar to Twitris, the most popular search items and hastags are additionally displayed in a LOD cloud.
- *Disaster 2.0* (Puras & Iglesias, 2009) consists of citizen-generated information and automated data captured by sensors. These are devided into events (e.g. flood), resources (e.g. police), and damages (e.g. victims). In a crisis, markers on Google Maps are tagged with the information.
- *Crisis Tracker* (Rogstadius et al., 2013) is a web-based platform that automatically tracks keyword sets of Twitter and constructs stories by clustering related tweets on their lexical similarity. It aims at improving real-time situation awareness.
- In *Twitcident* (Abel et al., 2012a) a profile is created based on information about a crisis event. In a second step, linked pictures and videos within the messages are accessed using aggregation modules. An initial categorization of the data is done by a Named-Entity-Recognizer. Finally, relevant tweets are filtered out.
- *Ushahidi* (Okolloh, 2009) collects data from various sources using crowdsourcing mechanisms and displays it on a map. The information especially consists of reports on the magnitude of damage and are created via a mobile app or a web-platform. The reports are subsequently illustrated as a picture on a map in real-time.
- *Mibazaar* (Liu & Palen, 2010) provides different crisis mashups based on Google Maps and Twitter. It visualizes social media information sequentially in real time, whereby mashups are predefined by hashtags.

The web-based approaches mentioned above clearly show the importance of citizen-generated content within emergency management, but they particularly focus on low-collaborative settings where actors are located at different places. As situation assessment practices comprise highly collaborative activities, which mainly take place in control centers of the respective emergency services and involve more than one actor (Ludwig et al., 2013), approaches have to be found, which live up to the collaborative character and face-to-face settings.

DEPLOYING MULTI-TOUCH TABLES IN CRISIS MANAGEMENT

The target to support situation assessment based on citizen-generated content from social media firstly requires a technology that is suitable for collaborative tasks. Due to the highly collaborative setting within control centers

where actors are located at the same place, laptops and tablets are only partially suitable for a joint asessment (Wallace et al., 2013). Especially with regard to the face-to-face communication and the joint view of content on large displays, we have decided to make use of a multi-touch table for displaying, because it fosters the analysis of data on a higher level of detail (Wallace et al., 2013). However, the examination of existing approaches for supporting collaborative situation assessment in crisis management based on multi-touch tables, which we will present, unveiled that they emphasize mainly geo-collaborative work on maps without integrating social media.

The project uEmergency (Qin et al., 2012) developed an approach to operate digital situation maps with pens. At this, each actor has an own map on which s/he can make annotations referring to a current crisis situation. All changes made on the individual maps are transferred to a large common map that supports crisis management teams in making decisions. The evaluation revealed that such map applications have positive impacts on the collaboration in large-scale disasters because all organizations get a quick overview. Doeweling et al. (2013) present coMAP, a further concept developed for planning on-site operations based on situation maps. Here, each user is given role-specific rights, which are managed by digital Anoto pens. The positions of the users are detected through the Bluetooth connection of their smartphones. Special menues have been created for the digital pens, e.g. the automatic alignment of dialogs. Compared to uEmergency, coMAP offers an enhanced spectrum of functionality for role-based identification. Kunz et al. (2013) developed Tangible User Interfaces (TUIs), which will activate certain functions if designated objects are put on a table. Hence, three TUIs arose, which support quick inputs and navigations on maps (Figure 1)). A further object makes the table display a timeline of crisis-related events. The study showed that the developed TUIs made the work on large maps much more effective, because it helped to invoke functions much faster, which otherwise would need complicated gestures on the surface (Kunz et al., 2013).

Figure 1: TUIs for working on maps (Kunz et al., 2013)

Tuddenham (2010) examined different methods to enter commands on multi-touch tables. He showed that physical objects are the best way to substitute complex gestures by putting them on the table surface. Artinger (2011) designed five input sets for efficient navigations on a situation map, where every gesture returns a visual feedback. They revealed that traditional gestures are most suitable for the work on maps and that it does not matter how many fingers are needed for a single gesture. A user interface which simulates crises events is a possible enhancement of programs, which use situation maps for crisis management (Kobayashi et al., 2006). In their study, applying different movable TUIs serves the purpose of simulating a certain kind of emergency at the position on the map. The project aims to simulate events as well as the appropriate response work. This approach demonstrates a way of using situation maps to prevent the spread of disasters (Kobayashi et al., 2006). Moreover, Wigdor et al. (2006) created a concept for a real-time monitoring of the New York's police, which is appointed for situation assessment as well as the coordination of on-site forces.

To summarize, our literature study has presented on the one hand approaches that try to make use of citizen-generated content within crisis management and on the other hand it suggests that a number of possible approaches for supporting collaborative practices in crisis management based on multi-touch table already exist. However, all existing approaches either are designed as low-collaborative web-based platform for the assessment of contents from social media (Abel et al., 2012b; Heim et al., 2011; Jadhav et al., 2009; Okolloh, 2009; Puras & Iglesias, 2009; Rogstadius et al., 2013; Starbird & Stamberger, 2010) or ignore the rich body of information within social media and focus either on the aspect of coordination with the aid of situation maps or interaction designs (Artinger, 2011; Doeweling et al., 2013; Kobayashi et al., 2006; Kunz et al., 2013; Qin et al., 2012; Tuddenham, 2010; Wigdor et al., 2006). We therefore try to harmonize both areas and examine the research question how collaborative work practices for situation assessment in crisis management can be supported by deploying multi-touch tables. Subsequently we will present a concept for the collaborative assessment of citizen-generated information on which basis we implemented the application CoTable.

COTABLE: COLLABORATIVE ASSESSMENT OF SOCIAL MEDIA INFORMATION

Since situation assessment in crisis management highly consists of collaborative work within the control center,

our application CoTable was designed for a next generation control room to support multiple persons at the same place in the analysis of citizen-generated contents from social media. CoTable was developed on the basis of a Microsoft PixelSense (formerly Microsoft Surface) multi-touch table (Figure 2).

Figure 2: CoTable on the Microsoft PixelSense multi-touch table

Individual workspaces are the foundation of a suitable, collaboratively utilized graphical user interface (Wallace et al., 2013), whereby the entire space of the table surface should be used optimally. The UI has to offer control elements and views for its joint as well as individual use, whereby a natural collaborative work is supposed to emerge (Deb, 2013). Due to the purpose of jointly analyzing contents from social media without the need for direct input interactions and the same hierarchical level of actors, we decided to not use a role system (cf. Doeweling et al., 2013). When developing our concept it turned out that complicated input gestures were not necessary for the specified functions, so we continued therefore without deploying TUIs (e.g. Artinger, 2011). As multimedia is of high relevance within social media, it should be integrated into the application, cf. Twitris (Jadhav et al., 2009) or Twitcident (Abel et al., 2012a). Contents that integrate location data, should be displayable on a map (Kunz et al., 2013). A search function should facilitate a fast navigation by immediately returning locations or contents the user searched for.

The surface of CoTable is designed for up to two workspaces arranged opposite each other and one joint workspace in the middle (Figure 3). The design for two persons ensures that each user has its own workspace, which is big enough for independent work, and there is still sufficient space for the joint workspace. In the following, we will present the functionality of the application CoTable which we have implemented.

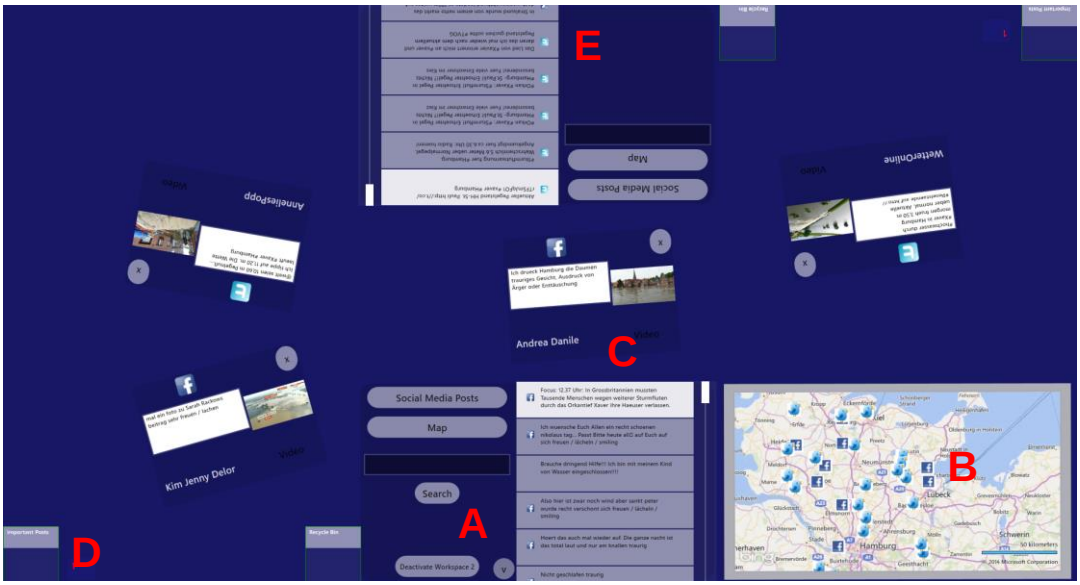

Figure 3: Overview of CoTable

A: The individual workspace. Initially, there is a single workspace at the long side of the table (Figure 4). This workspace comprises (1) a function for searching keywords or locations within social media, (2) a list view of

the search results, and (3) the option to activate the second workspace. The search for keywords or locations is implemented via a REST-interface and enables the continuous extraction of contents from social media, which correspond to the location as well as the keyword and its synonyms. To handle information overload for emergency services, CoTable is just a small part of an architecture and the content provided by this API is already pre-filtered by volunteers (Reuter et al., 2015). This pre-filtering ensures a summarization of relevant emergency-related information and CoTable is therefore implicitly capable to process high-speed content and outputs only relevant content for further expert processing by emergency services. Instead of an automatic pre-filtering, e.g. (Imran et al., 2014), the pre-processing of information is done manually by volunteers. The contents are displayed in a list through which the users can get a quick overview of all messages. At this, the respective content and the icon of the social media platform are visualized. At any time the user can activate (3) the second workspace (**E**). After its activation, all available contents are divided into two parts and distributed to the two workspaces, in what way the analysis can be carried out more effectively.

Figure 4: Individual workspace for one user

B: The map view. The contents from social media are visualized on a map based on its geographical reference (Figure 5). Those contents, which do not contain any location data and, therefore, cannot be represented on a map, are still displayed in the list (4). The contents are visualized by markers, where each marker displays the location as well as the source platform of the post. By clicking a marker, further details and multimedia data are shown (5). In order to obtain additional detailed information, the user can drag the message from the list view to the joint workspace, so that the detail view automatically opens, which then can be freely moved, enlarged, and rotated on the entire surface. Thus, further persons could deal with the map details.

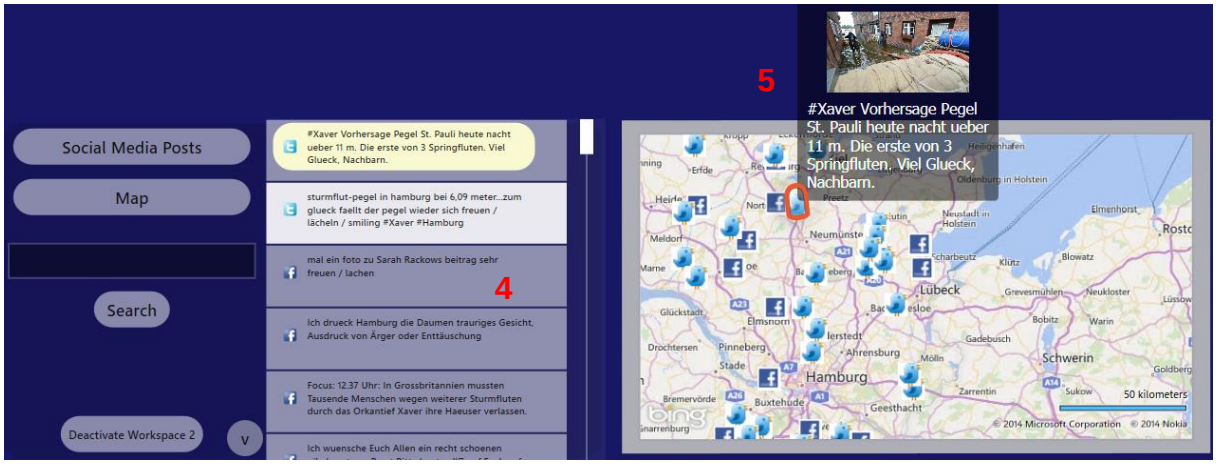

Figure 5: Visualizing information on a map

C: The collaborative object of social media. The „collaborative object of social media" is especially important for the implementation of the concept (Figure 6). The object (6) represents the detail view including further

options for interaction. The detail view consists of the icon of the social platform, the textual content of the message, the author, and, if available or linked, the associated picture or video. The object can be moved freely, rotated and enlarged, by what the joint analysis is aimed to be fostered. If a picture is available (7), it can be enlarged and moved independently. If a video (e.g. through a link) is available (8), a video player plugin will open and will provide the video as stream. This video player offers a start, pause, stop, and close function.

Figure 6: The collaborative object of social media

D: Collaborative sorting. Based on the collaborative object, users are given the option to store relevant or irrelevant social media posts, so that, if necessary, these can be transferred to and used within the control center's systems or be deleted (Figure 7). If a message is defined as important – that means it was dragged into the area of important messages (9) – it will disappear from the surface and a counter (here: red '2') will be incremented to create awareness among the participants. These data are stored as a JSON file for further usages.

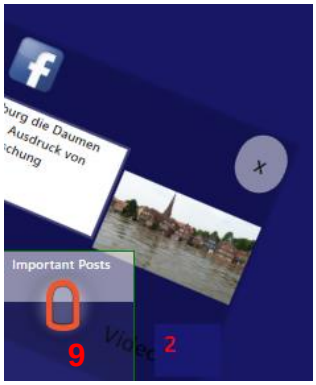

Figure 7: Storing important citizen-generated information

EVALUATION

Although CoTable was designed for collaborative settings in crisis management, its functionalities can be used also for other purposes of analyzing social media. Despite the full implementation of CoTable, the IT security regulations of the emergency services and organizations as well as the effort of transportation kept us from evaluating it with real actors from crisis management. The main limitation of our evaluation is therefore that we did not evaluate with real end users from the field of professional emergency services. Instead the group of participants consisted of students from various study courses to receive a broad spectrum of opinions – even they are not real end users (Table 1). Nevertheless, to ensure a realistic evaluation of our concept, we conducted a scenario-based walkthrough with 14 participants, followed by semi-structured interviews. The used guideline focuses on (1) the operability and presentation of information and (2) the collaborative finding of information in a time-critical flood emergency.

ID	Role	ID	Role

P01	Student Information Systems	P08	Student Information Systems
P02	Student Information Systems	P09	Student in Teaching
P03	Student Computer Science	P10	Student Information Systems
P04	Student Computer Science	P11	Student Social Science
P05	Research Associate	P12	Student Social Science
P06	Student Information Systems	P13	Student Social Science
P07	Student Information Systems	P14	Student Social Science

Table 1: Evaluation participants

Especially for the second part of the evaluation, we created a scenario to help the participants imagining a concrete use situation. The scenario comprised heavy storms with floods in Northern Germany. During the scenario the participants took the role of a member in a control center, whose task was to sort information from social media (here: Twitter and Facebook) by relevance using the multi-touch table and, as a result, to receive an overview of the situation (Figure 8). The data was based on real social media posts, which we captured and archived during the storm Xaver 2014 in the region of Hamburg.

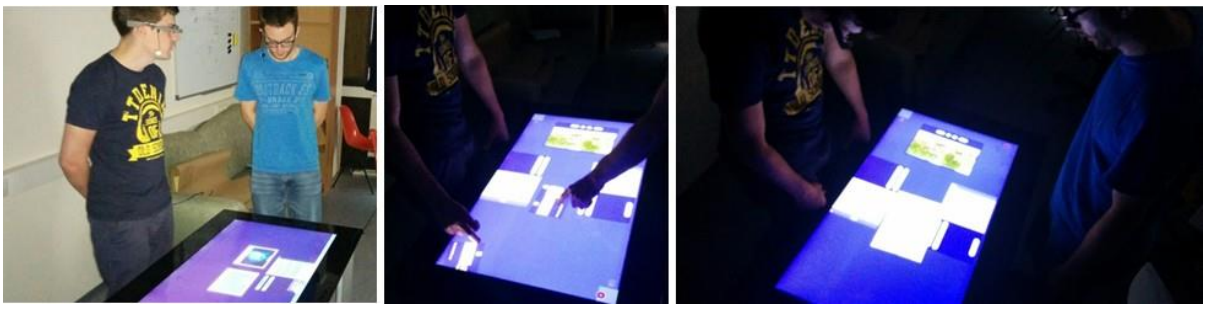

Figure 8: Evaluation setting

The interviews and its guideline served as a foundation for the analysis of our concept and ensured the comparability of the results. Additionally, the participants were asked to express their thoughts regarding their expectations and actions according to the "Thinking Aloud" method (Nielsen, 1993). In order to examine the collaborative practices during the analysis of social media, each evaluation procedure involved a couple of two participants, where each participant was equipped with a Google Glass, so that we were able to capture directions of viewing, head movements, motions and get additional audio/video recordings. The audio and video recorded evaluations were later transcribed for data analysis. Each evaluation lasted about 60 minutes.

Results

The evaluation of CoTable revealed that the application in its current form can support a quick and efficient analysis and sorting of contents from social media, especially within collaborative settings: *"Definitely quicker, since the alternative would be to sit in front of a computer and to search for messages by yourself"* (P14). The design of the surface was highly appreciated by most of the participants due to the fact that the given sorting and valuating tasks could be accomplished quickly: *"The idea or the basic frame makes sense"* (P11).

The search functionality was particularly well received (P13). Moreover, the option to move and jointly view videos and pictures was seen as useful: *"I think it is good that you can watch videos together"* (P09). Furthermore, the interconnection between the map and the list view was seen positively because, as a result, the messages could be found more quickly based on its location: *"This clicking on the map and marking it yellow on top is good"* (P10). One participant judged the current procedures positively: *"I think you can collaborate really well; it is cool that you can just move a piece of information to another person so easily"* (P09).

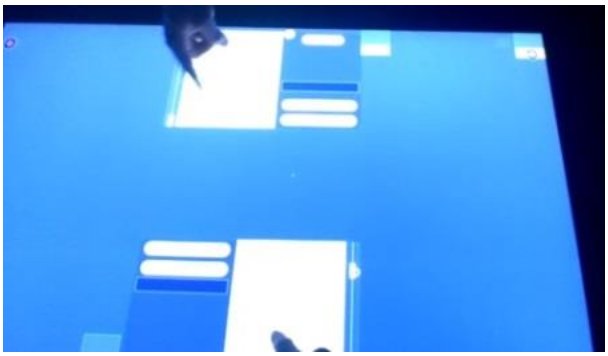

Figure 9: Moving a message directly from the list

Some control elements of the interface were considered to interfere with an intuitive use of CoTable and to impede the entire work process. In each evaluation the participants tried to move clearly relevant or irrelevant messages directly to the corresponding folders (Figure 9). But since the messages first need to be opened in the detail view, the work process was interrupted. Additionally, participants expressed the need to make the interface more intuitive by using icon buttons instead of text buttons (P01, P06, P07, and P08).

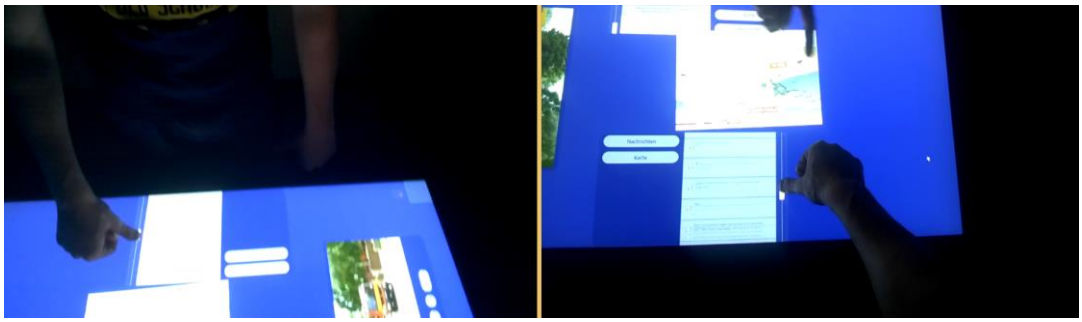

Figure 10: Opposite views of participants with Google Glass

The collaboration – the intended goal of the application – offers lots of areas and potentials for improvement. The reason for this lied, on the one hand, in too unambiguous messages, which could be sorted without the need for communication about their relevance, and, on the other hand, in the design of the interface and subsequently the positioning of the participants around the table. It was suggested to work at only one side of the table to increase the collaborative activities (P03, P04). *"Better work is possible when standing next to each other; facing each other makes it faster to work through the messages but with less collaboration"* (P10). It was recommended to work together on one side and to use the opposite side for only one window: *"The main window, if it is only one, could be at the top of the screen and everyone has their own space at the bottom"* (P10). Furthermore, suggestions were made on the level of responsibilities for various tasks. Only one work space should exist, but the tasks should be divided into two areas: *"One for the important posts, the other one for the recycle bin"* (P11). In order to check this out, the participants of one evaluation procedure deactivated the second work space and continued to work on one side. From the participants' point of view, the result was clearly better – however, a comparable evaluation has not been conducted. When asked which of the own suggestions made during the evaluation were the most important ones, most of the participants answered that especially those changes were important which make the work quicker, such as highlighting signal words: *"Maybe you could highlight signal words, which appear constantly"* (P07).

Google Glass was highly accepted as evaluation tool and the subjects would again participate in an evaluation in which it is used. Their curiosity about new technologies may be the reason for that. However, we have noticed that the recording field of the glass is often too small to see what a participant is doing what on the surface. Here the evaluation with two persons at the same time was an advantage, because the actions of the partner on the opposite side could be recorded for most of the time (Figure 10).

CONCLUSION

Citizens increasingly communicate via social media during crisis situations, which entails that the integration of social media content will become more important for professional situation assessment practices. Our research

aimed to support collaborative situation assessment with regard to social media content. We therefore initially analyzed the role of citizen-generated content in crisis management as well as the deployment of multi-touch tables. In our literature study it became apparent that multi-touch tables can support face-to-face communication and, subsequently, collaborative work. In almost all studies, which focus on the support offered by multi-touch tables, a map serves the purpose of visualizing events and crisis management, but without including information from social media for situation assessment. Those approaches, which already include social media for situation assessment, focus on web-based applications with neither collaborative nor face-to-face settings. But our vision was to bring both, the analysis of social media content and the support with multi-touch tables, together for developing technologies that could be of interest within next generation control rooms. The underlying research question was therefore how the collaborative analysis of social media in crisis management can be supported by the use of multi-touch tables. To answer this question, we designed and implemented the application CoTable for Microsoft PixelSense (formerly Microsoft Surface), which provides basic and collaborative functionalities for reviewing, sorting and valuating social media content. Afterwards, we conducted an evaluation with a total of 14 participants.

The evaluation revealed that the implemented application has the potential to improve situation assessment in the control center of emergency services by supporting staff members in finding relevant messages. But in the participants' opinion, the potential of the table to support collaborative work was not fully used. One reason was that messages used in the evaluation were too unique, wherefore communication and discussions were not necessary. The high subjectivity of the participants in regards to the collaboration and positions clearly showed that the statements about technical requirements are based on individual feelings and opinions. A limitation of the study was that the group of participants was small and too different regarding their qualification to make explicit statements about, for instance, which position at the table is most suitable for a specific task. But the study's main limitation is the evaluation with non-experts in the field of crisis management and therefore its significance for the actual work of emergency services. Our study therefore tries to pave the way for further developments for next generation control rooms. In our future work we therefore plan to evaluate CoTable with with an adapted interface and a larger group of participants – especially experts from the field of crisis management to conclude its impact for their response work in practice with domain knowledge.

In order to support collaborative situation assessment on the basis of social media content with the aid of multi-touch-tables, three 'lessons learned' have to be considered: (1) If the actors stand next to each other and share one workspace, they will have the subjective feeling of a more intense collaboration; however, workspaces arranged opposite each other foster a more efficient content review. (2) If the actors divide their areas of focus (e.g. one person only deals with relevant and the other only deals with irrelevant messages), the content review process can be subjectively improved. Important signal words or relevant excerpts from social media should always be visualized for the users. (3) If evaluations are planned in collaborative work settings on the basis of social media content, the contents have to be selected thoroughly – they especially should not be too unique – in order to offer some need for discussion among the participants. Additionally we made the experience that the collaboration of the multi-touch-tables that deal with infrared has to be designed for darkish rooms because the infrared panel used by the table strongly reacts to light, particularly sunlight.

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