Journal of Media Critiques [JMC]
doi: 10.17349/jmc118226 P-ISSN: 2056-9785 E-ISSN: 2056 9793
http://www.mediacritiques.net jmc@mediacritiques.net

A MOBILE CLOUD COMPUTING COLLABORATIVE MODEL FOR THE SUPPORT OF ON-SITE CONTENT CAPTURING AND PUBLISHING

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ABSTRACT

The current paper investigates the design of a collaborative Mobile Cloud Computing model to support the workflow of collecting, editing and publishing news reporting material, aiming at better managing technology and human resources. While semantic services and tools have made tremendous progress in both academic and applied level, journalists don't seem to make the most of contemporary technological possibilities. With the proposed framework, journalists, reporters, technical experts and editors can cooperate remotely and simultaneously on the cloud, collaboratively producing and publish timely, authentic and high-quality content, with proper documentation. Context- and location-aware semantic metadata, provided by mobile devices, guide the field reporter, while also serving annotation and authentication purposes. State-of-the-art mobile publishing tools are used for capturing and processing multimodal assets, which are then uploaded to the cloud. Augmented interaction tools (speech-to-text, voice commands, etc.) can boost usability to overcome the functional constraints of mobile devices, thus facilitating reporting services and improving the overall media experience. Technologists /expert-collaborators monitor the process to meet the quality standards posed by the news reporting team or organization. The adopted human-centred design aims at serving the needs of modern journalists, concerning functionality and effectiveness, promoting their professional development through in-service training. This is succeeded with the implementation of rapid /pilot prototyping and evaluation cycles, in which the project is progressed, leading to the suggestion and the adoption of best practices, within the scope of further automating news reporting procedures.

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Keywords: Mobile media, news-reporting, cloud computing, content management, media semantics.

INTRODUCTION

The Internet has influenced the Journalism profession in two aspects (Deuze 2004): the conception of a journalistic profile for all media types and the creation of unique working practices. Deuze (2003) focused on the Online Journalism, defining it as the fourth type of Journalism, while Pavlik (2001) claimed that Internet established a new journalistic style, namely 'Contextualized Journalism'. Moreover, the terms "multimedia", "interactivity" and "connectivity" were introduced by the development of digital communication technologies, introducing new functions into working places and day-living.

New opportunities and structures have been developed in the media industry, benefited primarily by the evolution of Information and Communication Technologies (ICTs). Within the news landscape, journalists face a cluster of innovations, including the increased use of digital communications and social networks. As news organizations experiment with new ways of doing business, relationships between journalists and their communities are continually reformulated, reconfiguring the professional culture (García Avilés et al., 2004; Lewis, 2012; Ryfe, 2012; Singer, 2004b, Ekdale et al., 2015). The media convergence "phenomenon" had many consequences on the newsroom, affecting both content production processes and journalists' profiles (Dailey et al., 2005; Salaverría et al., 2012). Journalism 2.0 has surfaced because of the media convergence and participatory culture (Jenkins, 2008), concerning the production, distribution and sharing of news with the use of social media, while improving the interaction between information producers /publishers and their audiences (Briggs, 2007; Ureta, 2017). Online journalists are expected to have extra skills and be more adept at cross-media reporting than their counterparts in print and broadcast media, as well as to demonstrate a special capacity for cooperative effort and teamwork.

Nowadays, people have many opportunities to instantly access news and other generic-purpose information, but also to produce and share their own content. The exponential growth of the smartphone market and the number of "mobile users", along with the contemporary mobile media capabilities and the rapidly evolved Mobile Cloud Computing (MCC) paradigm, have led to large-scale development and deployment of related news applications (Dimoulas, Veglis & Kalliris, 2014; Dey, 2012; Sidiropoulos & Veglis, 2017). Users became active participants in the communication process, being able to act as content contributors as well. The boundaries of the different forms of media, such as radio, television and newspapers, have been blurred, the same way that the (different) roles of journalists and readers/audience are not very discernible. These new technological affordances (Ottovordemgentschenfelde, 2016; Rettberg, 2008) and their associated structural changes (Lowrey, 2006) formulate a new landscape, with the personalized participatory forms of journalism fuelling the traditional 'paradigm of objectivity' (Hackett, 2009; Reese, 1990; Chong, 2017). Researchers started to examine

the changing nature of newsgathering and reporting amid data abundance, in which, computational exploitation and algorithmic automation capabilities have growing significance for the media industry and Journalism, as practice and profession" (Lewis, 2015; Jung et al., 2017).

On the other hand, Carlson (2015) expressed his concerns about the future of journalistic labour, compositional news forms and the foundation of editorial authority, characterizing the Automated Journalism "disruptive". Media professionals have had to tackle professional (cultural and regulatory) and organizational challenges when dealing with convergence processes. With regards to the latter, fear of deterioration in working conditions and the establishment of the role of the multi-skilled journalist have been the pervasive features of most of the convergence initiatives analysed (Micó et al., 2013; Wallace 2013). Some arguments of the "Traditional Journalism" defenders are: a) the reconstruction of the newsroom is perceived as cost-cutting measures (Quinn 2005), b) the production of content tailored is more time-consuming, and c) the implementation of a computational model impacts negatively on news quality (Cottle & Ashton 1999).

Cloud services support data sharing and offloading of computations into a network-centric perspective (Mei at al., 2008; Sultan, 2011; Rittinghouse & Ransome, 2010; Hoefer & Karagiannis, 2010). Such a model could be ideal to support journalists' actual needs and practices around their work and information flow, subjected to a careful assessment of a dedicated technological solution. The workflow defines the specification and the execution of a set of coordinated activities, representing a business process within a company or agency (Borghoff & Schlichter, 2000). A local/traditional media corporation typically consists of a group of people working in connected tasks, aiming at facing the arisen editorial demands. Efficient cooperation is the key to successful journalistic work that requires developing and managing co-creative processes, asking team members to comply with the calls for awareness and collaboration. Similar complementary competencies and skills are required in the "digital news environment" and, particularly, in the Online Journalism context (Malmelin & Villi, 2015). This necessity is further intensified by the "any-time" and "from anywhere" aspects that newsgathering should feature, allowing reporters to act remotely from the corresponding news-scenes, i.e. the locations that events take place (Dimoulas et al., 2014). The use of web-based Collaboration Work Environments (CWEs) could support such demanding workflows, using ICTs and distributed /distant co-working as basic components (Avraam et al., 2004). The current paper focuses on the development of a collaborative MCC model, aiming at enlightening and answering the various questions of contemporary news collecting, managing and publishing with the help of mobile terminals.

TECHNOLOGICAL BACKGROUND AND CURRENT STATE OF RESEARCH

The transformation of the technological landscape concerning news production in the past decade has raised entirely new needs, reshaping the traditional workflows of a typical newsroom. Social Networking Sites (SNSs), User Generated Content (UGC), Citizen Journalism (CJ), Internet facts gathering-checking and web publishing have

rendered the newsroom responsibilities ever-changing field. New professional skills are required, while media experts' teams are formed in many news organizations to handle the novel needs (Umair, 2016). In 2011, CNN, Associated Press, Al Jazeera, NBC and Sky News already provided their audience with mobile applications, to interconnect them with their newsroom and support direct sharing of the citizens' content and stories /articles (Mills et al., 2012). It has been stated that mobile newsgathering platforms should account metadata concerning the participants' characteristics (Väätäjä et al., 2013), while semantic analysis of the crowdsourced material can lead to the development of information recognition /classification automations and related ground-truth databases (Dimoulas et al., 2014; Vrysis, Tsipas, Dimoulas & Papanikolaou, 2015;2016).

Mobile Journalism (MoJo) inherits some of the qualities of UGC, in the sense that professional journalists cover news-events using commonly available equipment, without the need of mobile news broadcasting workstations. Especially in the usual cases of live reporting or breaking news, MoJo practices can allow the simultaneous action of multiple mobile terminals, which is more affordable, offering even quicker coverage and broadcasting (Guribye & Nyre, 2017). Obviously, centralized newsgathering/reporting infrastructures are needed, interconnecting multimedia capturing and managing facilities with the newsroom (Mills et al., 2012). Along with production, news consumption has been equally affected by recent technology developments and trends (Westlund, 2015). More people daily choose mobile phones, news-sites and SNSs for getting informed instead of traditional media. Hence, effective news-production should fulfil the needs of a diverse audience, whose news-reading preferences differ according to demographic characteristics and personal preferences. Recommendation systems have been proved useful to fill the gap between production and consumption ends, so that the published stories can reach the final consumers (Lu et al., 2015). Machine Learning (ML) approaches are applied to cluster the audience and distribute news (Jordan & Mitchell, 2015). Smart systems collect information concerning users' activity, preferences and interconnections between individuals, thus exploiting them to train models that predict which stories are appealing to different groups. Geographical data is easily available, especially for mobile users, facilitating locative news services (Goggin et al., 2015). Therefore, stories and overall media assets should be semantically annotated and categorized during production/post-production, offering location-aware reporting services.

Smartphones have evolved into portable workstations for audiovisual capturing and context-aware collecting sensors. Their multisensory design provides a whole array of data/digital sequences for interacting with the physical environment and capturing information. Built-in cameras and microphones for audiovisual recording, Global Positioning Sensors (GPS) for geographical localization, accelerometers and gyroscopes to monitor the movement and direction of the device are available and constantly accessible to more and more professional and non-professional users (Al-Turjman, 2016; Dimoulas et al., 2014; Vrysis et al., 2016). These capabilities come along with

communication interfaces and almost ubiquitous broadband internet connectivity. From an Internet of Things (IoT) perspective, smartphones integrate many crucial news reporting tools (text, images, audio-video streams, etc.) interconnected in a network. While the quality of built-in audiovisual sensors is mostly oriented towards a minimum-requirements non-professional audience, the rapid growth of MoJo has led to the development of a new market of professional-level smartphone equipment. Externally attached lenses make the captured footage comparable to professional handheld cameras, therefore suitable for news reporting. The choice of different lenses provides versatility in the characteristics of optical zoom, focal length etc., allowing to select the most appropriate items for every shot. External microphones are available and can be used for better sound quality, through closer placement or distant audio recordings (i.e. shotgun microphones). Power banks and external memories help surpass the battery and capacity restrictions (Burum & Quinn 2015).

Mobile news-reporting takes advantage of the many applications for audio-video editing and broadcasting available for Android and iOS. Reporters can adjust camera settings through dedicated applications and record videos, either for live-broadcasting/-streaming or post-production purposes. Trimming, editing, and assembling videos, applying filters, manipulating multi-track sound, adding voiceovers, subtitles and graphics are possible in smartphones through various applications. MoJo applications like Vimojo offer comprehensive environments to perform all the above operations and export the final media product. Many of these apps provide geolocation metadata for the original captured material using GPS (Burum & Quinn 2015; Dimoulas et al., 2014; Sidiropoulos, Konstantinidis, Kotsakis & Veglis, 2015). While the individual tools are available and mature, there are still missing dedicated newsgathering applications, interconnecting mobile terminals with the remaining parts of the reporting/editorial-processing chain into integrated models /environments. Apparently, these solutions should be adapted to the journalistic principles and the publishing policies of the different media organizations, so that geographical and cultural divergences are expected. For instance, in the Greek media practice, additional difficulties arise concerning the characteristics of the cellular networks (i.e. coverage, bandwidth, etc.), weakness related to language processing automations (i.e. text recognition, speech-to-text tools, etc.), or even the technological know-how of the involved users. Given this demanding case of Greece, the current work is part of a long-term project, aiming at supporting modular, customizable and integrated MCC services that can be adapted to various mobile news-reporting scenarios.

THE PROPOSED FRAMEWORK

Methodological Approach

In the current paper, a framework for intelligent mobile news reporting is investigated. The approach adopts the concepts of anthropocentric design and rapid prototyping. Continually evolving prototypes will be initially implemented, following the standard iterative software engineering procedures of analysis, design, development and

evaluation. Great emphasis is given on the participation of the targeted users in the entire implementation process, including their training on the proposed services in real use scenarios, through targeted assessment sessions and empirical studies. According to the LUCID methodology (Logical User-Centered Interactive Design), the design of these services will not only consider the requested functions (what the product should do) but will also focus on the requirements from the user's point of view, ensuring Effectiveness, Efficiency, Quality of Service, Error Tollerance, Simple Recovery, Ease of Learning (Dimoulas, 2015; Kreitzberg, 2008). The stages of the adopted LUCID model are depicted in Figure 1.

An analysis for quantifying the familiarity of the reporters on the use of modern MCC technologies will take place in the form of public inquiry, supported by questionnaires and experimental assessment sessions (i.e. lab exercises). This investigation has been designed based on our valuable experience acquired from successfully finished similar projects and will be conducted with the help of well-known partners of the M3C research group (Multidisciplinary Media & Mediated Communication, m3c.web.auth.gr). The participation of students and professional journalists from various organizations (CNN-Greece, eklogika.gr, amna.gr, tvxs. gr, ert3.gr, esiemth.gr, etc.) and the contribution of dedicated trainees ensure a substantially solid sample to test the upcoming technological possibilities and preferences for the next generation journalists. A broad set of parameters is considered (use of technologies, level of study, professional specialization, etc.), including the inquiry of the participants and the submission of open-type feedback. Significant attention is needed for applying the appropriate weighting to avoid bias in the results. For example, people who are not sufficiently adapted to contemporary technologies may be driven to trivial or overwhelmingly advanced workflows, considering the technological level of the planned services.

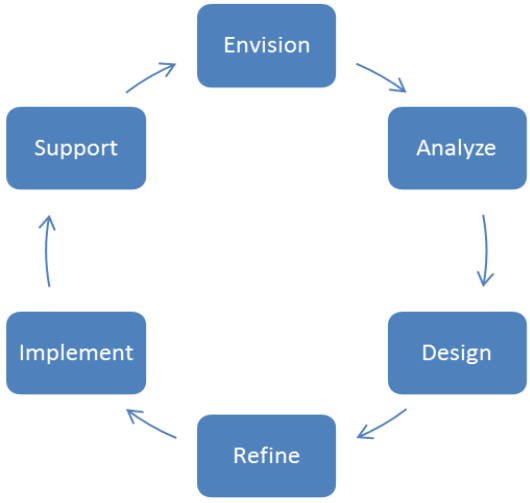

Figure 1 The LUCID model is organized into six stages

Bibliographic review and research on the target group's needs lay the foundation for revising and fine-tuning the original idea. Additional surveys will finalize the technical specifications of the proposed solutions, by prototyping graphical user interfaces (GUIs), workflows, wireframes and developing demo applications. The conclusions of this phase will unveil the degree of technological maturity (particularly in Greece), providing useful data to be taken into consideration for the design and development phases. The products of these procedures will be tested and evaluated at each stage of development process, as the principles of user-centred design define. At this point, more specific tasks are included, such as: exploring technical specifications and environmental parameters, reviewing similar software implementations, analysing users and tasks, defining standard use-case scenarios, designing flowcharts of actions, defining usability issues, deriving technical constraints and managing troubleshooting. The analysis is completed by all the findings and the conclusions to be used in the design phase.

Project scheduling and development of the envisioned model

As already implied, the current research is part of a longer-term project, aiming at implementing prototype MCC applications for integrating "smart" news-reporting services. The envisioned news-reporting model and the adopted MCC architecture are presented in Figures 2, 3, while the adaptation of the LUCID methodology to the scheduled workflow is depicted in Figure 4. It can be noticed that most of the wanted utilities, discussed in the previous sections, can be served within the proposed modelling. Specifically, reporters can use their mobile terminals while they are navigating in the areas where news-events are taking place, receiving valuable guidance concerning the approach/locations of the news-scenes and the associated context behind the investigated stories (Dimoulas et al., 2014). They can also exploit the offered audiovisual recording tools and the inherent networking capabilities to capture and upload news-content on the cloud, for online sharing and/or further processing, before its final push to multiple publishing channels. The submitted material is semantically enhanced with location- and context-aware metadata that mobile sensors and services induct, thus supporting proper documentation on the cloud repository. Software modalities and automation algorithms propel active collaboration between specialists of various domains (journalists, media producers, ICT-experts, etc.), supplemented with continuous training and support actions, while facilitating efficient media assets management (for both mobile and desktop users, i.e. field-reporters and desk-working journalists/editors). In addition, computationally heavy tasks (i.e. content/semantics processing, algorithmic automations, etc.) are offloaded to the cloud, so that they can be operated even from resource-limited mobile terminals. Most of all, reporters and citizen-journalists can interact in multimedia terms/data, taking full advantage of the offered audiovisual mediated communication mechanisms, thus overcoming possible interfacing limitations.

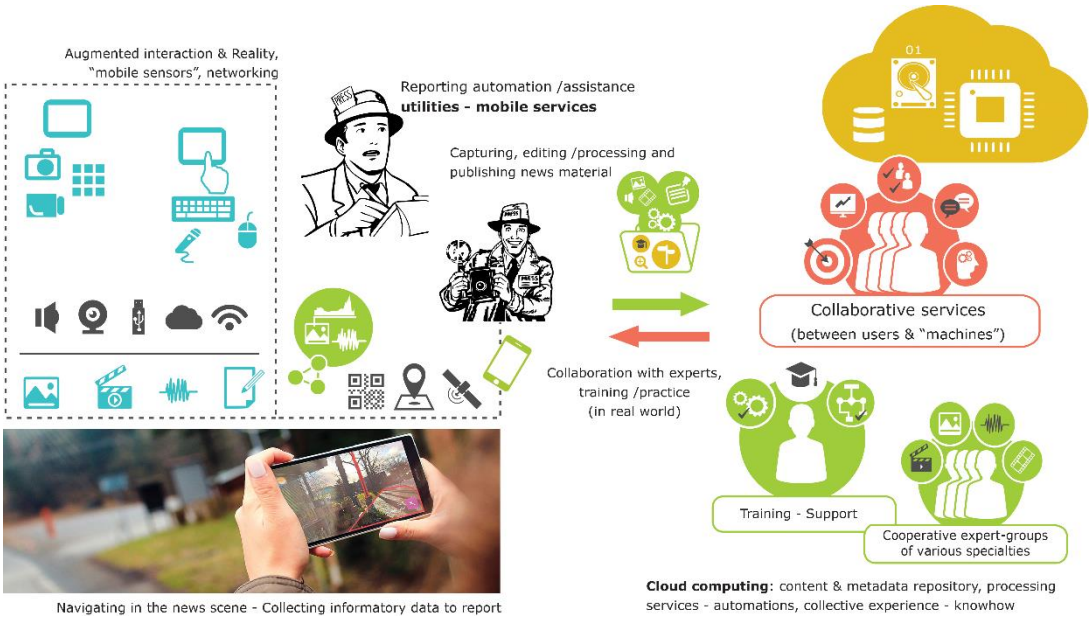

Figure 1 The proposed news-reporting collaborative model

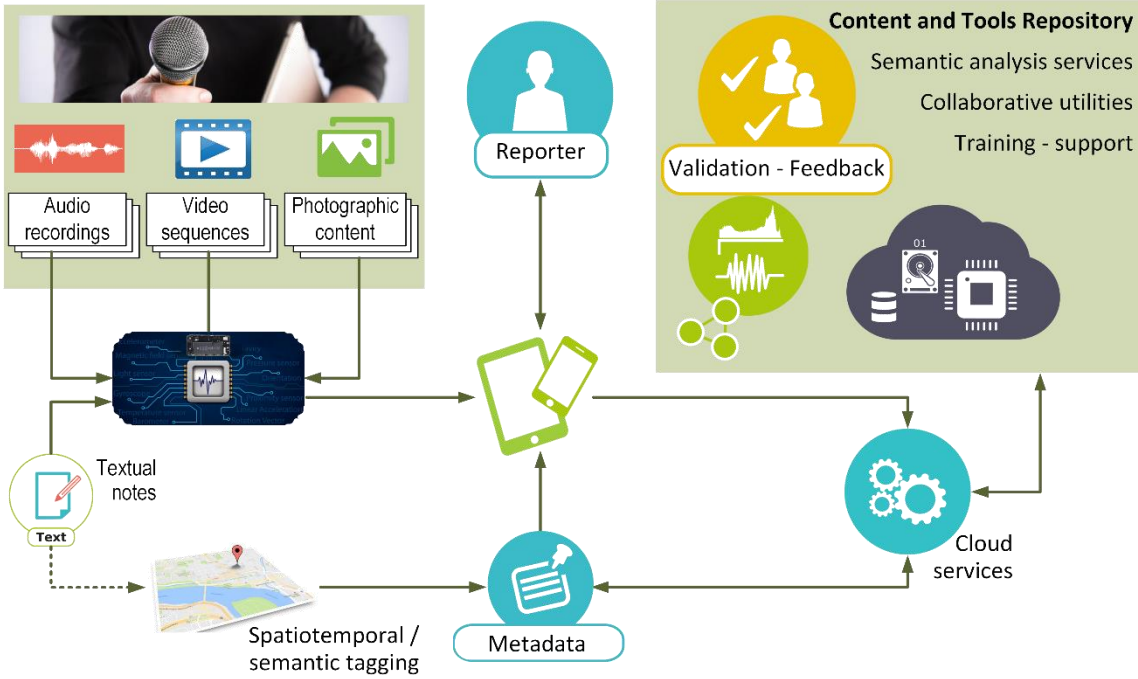

Figure 2 The adopted MCC architecture

Regarding project execution, starting with the main idea, the initial specifications and the results of the subsequent analysis will later evolve into design products. The activities of this stage focus on the designing thoughts (mockups and sketches), specifying usability objectives according to functional preferences, developing typical use-scenarios, defining central navigation nodes/routes and interfaces, creating design guides and interaction mechanisms, adopting thematic categories of basic screens, etc. Thereafter, fast prototyping and interactive development can be deployed, while usability assessment and feedback of targeted users/groups are constantly received, as indicated in Figure 4., ensuring succesful implementation that meets users' needs.

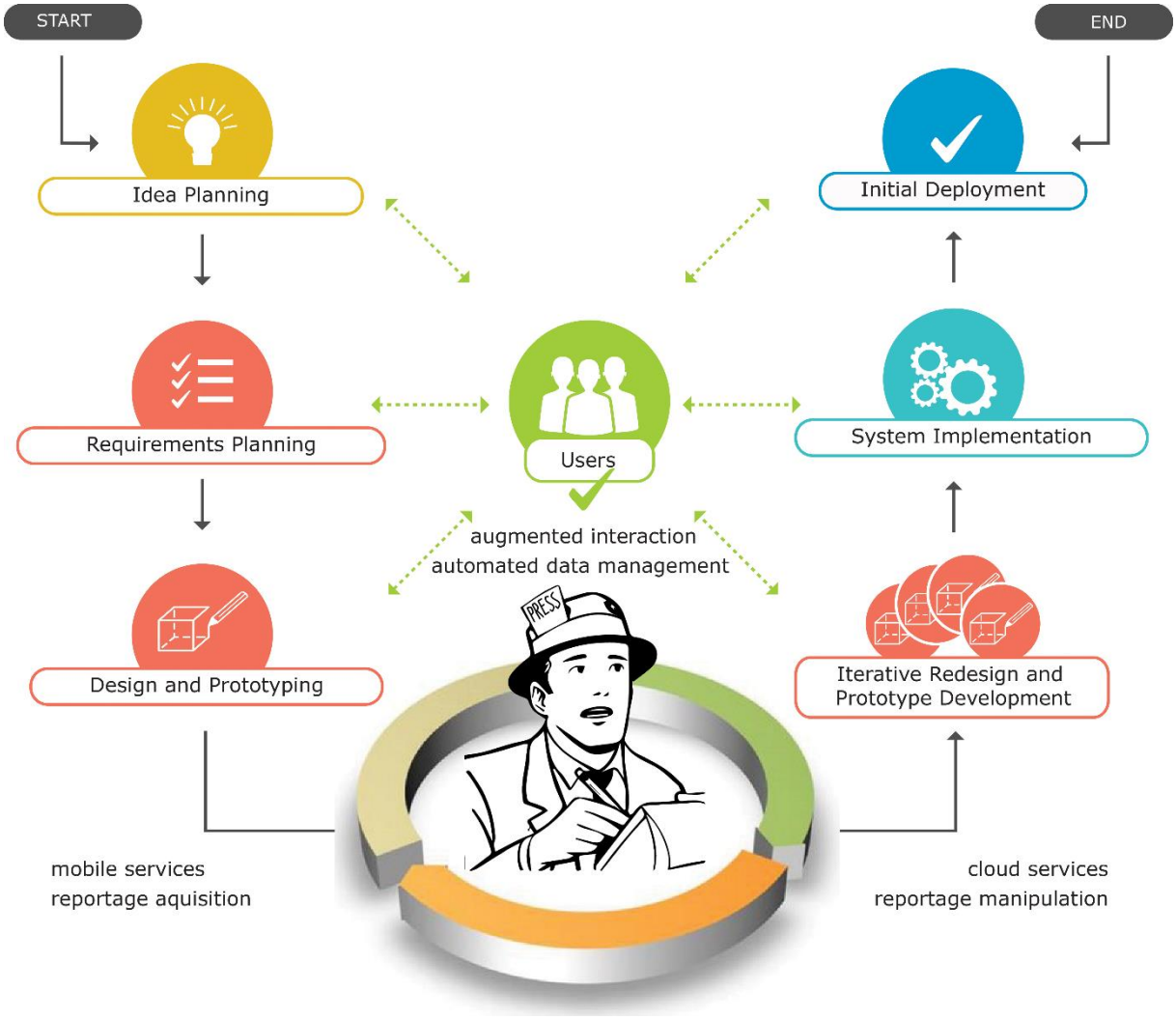

Figure 3 An overview of the proposed workflow

Interactive Prototyping Design

According to the primary goals of the current project, the tools under design will focus on meeting needs in the following three axes:

- Modelling of data structures covering the needs of journalists and the functions of the computational model.
- Designing software that will capture multimedia (text, photo, audio, video), providing tools for quick editing (cropping, resizing, etc.), annotating and storing.
- Engineering of a central computational environment that will facilitate data management integration, offering information-exchange, searching and retrieval with semantic analysis capabilities and indexing automations.

The above axes are fundamental principles for the development of an integrated toolset, which will support the coverage of needs in the management of journalistic information. The main architecture of the overall system is based on assumptions and technological data, considered up to now. Thus, initial assessments have been made to the necessary data and metadata structures that should support the evidence of journalistic reporting as shown in Figure 5.

Figure 4 Supported data and metadata structures for news reporting

Semantical and spatiotemporal tagging has a unique role, without the need for manual input of data by the user (Vrysis et al., 2015;2016). Due to the cloud implementation, all features will be available simultaneously to many users who can collaborate remotely (Vrysis et al., 2015). The data view and processing capabilities will be adapted to the needs and capacities of each terminal, implementing a responsive design (Hay, 2013). Initial mockups for the mobile/client interface are presented in Figure 6. Design proposals will take a specific form during the deployment phase. Synthesis and interconnection of technologies concern a wide range of existing applications. The implementations will be based on software development tools that primarily favour research, rapid prototyping and usability testing (Python, Java, Balsamiq Mockups, InVision, Axure RP) (Bank, 2014). The development phase includes the server-side tasks of database implementation for content storing and retrieval (data and metadata), the design of the semantic analysis algorithms, the adoption of specific classification taxonomies/hierarchies and the materialization of the multimodal event

detection and segmentation components. The list is completed with the client-side mobile capturing, documentation and publishing of the news-material, along with the integrated computing interface for all services, which can be accessed through both desktop and mobile terminals. Given the importance of the training and support procedures, the proposed workflows will be optimized while testing, launching, at the same time, the necessary user-manuals and training sessions.

Figure 6 Prototypes of the mobile app interfaces

An essential aspect of the successful completion of the project is the exhaustive evaluation during all phases (Demetriades et al., 2004; Dimoulas, 2015). Formative assessment is performed from the initial design stages, both internally, by the workgroup, and externally, by a sample of experts/targeted users. Summative evaluation will also be conducted at project completion. Heuristic investigation and performance metrics will be deployed to assess the usability of the designed prototypes and services (Albert & Tullis, 2013; Avouris, 2000). Representative users/groups, formed by participants from various media and trainees, will test the implementation of the proposed tools in real-world use-scenarios. Cumulative analysis of the results will form the ending conclusions, guiding the final process of reviewing.

RESULTS AND CONCLUSIONS

The current framework models Computer-Supported Cooperative Work dedicated to news production and publishing. The use of a novel smartphone application is in the core of the design, taking into consideration all the workflows, i.e. multimedia asset production and management, communication with the newsroom, broadcasting and cross-/trans-media publishing, etc. To address the problem globally, a collaborative MCC model is introduced, providing an environment that brings together the professionals

involved in the news-reporting chain (reporters, journalists, editors, technicians, etc.). Hence, all these actors can remotely, though efficiently, cooperate on the cloud. Reporters are equipped with smartphones having all the needed hardware /tools for recording, saving and editing multimedia assets within the same software environment. Journalists require for special training on multimedia production, but they don't have to be specialized at expert level. The produced material is uploaded to the cloud, where it is accessible by the newsroom and audiovisual engineers who can edit or make corrections to the multimodal assets. Getting everyday feedback from collaborating with the experts provides practitioner training to reporters.

Semantic technologies are integrated to facilitate interaction between the journalist and the application, while also annotating the produced content. Speech-to-text, voice commanding and intelligent editing tools support the reporters' tough job of on-the-fly multimedia production. Audiovisual event detection and classification, descriptive annotation of stories and geolocation information provide metadata for immediate tagging of the produced news-content, to feed documentation and management automation modules in the newsroom. Recommendation systems are not only oriented to news publishing, but also for suggesting associated stories-covering (i.e. reporting articles and UGC with similar content, category, geolocation, etc.), thus facilitating storytelling enrichment while also making factchecking easier. For the case of the mobile journalist, monitoring his/her location can recommend an efficient way of distributing event coverage to the media organization human resources, taking into consideration proximity of breaking-news locations.

Long-term usage of the integrated news reporting framework will gradually augment the cloud repositories with audiovisual semantic metadata and log-files, monitoring the collaborative actions. The enrichment of ground-truth knowledge-bases will be used for retraining the automations of workflows to more intelligent and robust versions. Overall, the experience gained by using the new tools will significantly facilitate the newsgathering and publishing tasks, thus leading to the adoption of well-tested best-practices.

ACKNOWLEDGEMENT

This research has been supported by the Operational Program "Human Resources Development, Education and Lifelong Learning" and is co-financed by the European Union (European Social Fund) and Greek national funds.

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