Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 56 (2015) 544 – 549

Procedia Computer Science

International Workshop on Mobile Information Systems (MSIS 2015)

AEGIS App: Wildfire Information Management for Windows Phone Devices

Nikos Athanasis*, Fotis Karagiannis, Palaiologos Palaiologou, Christos Vasilakos, Kostas Kalabokidis

Department of Geography, University of the Aegean, GR-81100 Mytilene, Greece

Abstract

Novel technological advances in mobile devices and applications can be exploited in wildfire confrontation, enabling end-users to easily conduct several everyday tasks, such as access to data and information, sharing of intelligence and coordination of personnel and vehicles. This work describes an innovative mobile application for wildfire information management that operates on Windows Phone devices and acts as a complementary tool to the web-based version of the AEGIS platform for wildfire prevention and management. Several tasks can be accomplished from the AEGIS App, such as routing, spatial search for closest facilities and firefighting support infrastructures, access to weather data and visualization of fire management data (water sources, gas refill stations, evacuation sites etc.). An innovative feature of AEGIS App is the support of these tasks by a digital assistant for artificial intelligence named Cortana (developed by Microsoft for Windows Phone devices), that allows information utilization through voice commands. The application is to be used by firefighting personnel in Greece and is potentially expected to contribute towards a more sophisticated transferring of information and knowledge between wildfire confrontation operation centers and firefighting units in the field.

Peer-review under responsibility of the Conference Program Chairs

Keywords: mobile GIS; wildfire management; Cortana

* * Corresponding author. Tel.: +30-22510-36437; fax: +30-22510-36439.
E-mail address: athanasis@geo.aegean.gr

Peer-review under responsibility of the Conference Program Chairs
doi:10.1016/j.procs.2015.07.249

1. Introduction

The ever increasing frequency of wildfire events in Greece and in other parts of Europe is a growing problem for firefighting agencies, governments and societies, resulting in a variety of undesired fire effects on economy, natural ecosystems, public health issues and fatalities. To cope with these outcomes, a considerable amount of funds have been delivered from European Union (EU) and national governments to research institutions to support research on new technologies that can aid in preparedness, wildfire confrontation procedures and recovery issues. Results are spanning from installing wildfire detection cameras and remote automatic weather stations (RAWS) on high risk areas for surveillance and early detection, creation of decision support systems (DSS), design of mobile applications, even deployment of drones with sensors over forested areas.

Mobile computing systems and hardware are changing the way mobile mapping technology is being used by moving Geographic Information Systems (GIS) from the desktop into the user's hands. This evolutionary transition provides flexibility in data acquisition, data accuracy and integrity, while the integration of Global Positioning Systems (GPS) into the mobile devices gave birth to a whole new variety of applications with novel possibilities. Furthermore, real-time validation is reducing errors and process costs, while more information with much less time and effort, faster communication protocols and high productivity makes the mobility an enticing aspect of GIS[1]. All of these improvements now make it possible to bring field and office activities into a collaborative environment that can further improve productivity, reduce costs and minimize projects' completion timeframes [2].

Over the last years, software producers have developed several mapping and GIS software packages that operate through mobile devices. The utilization of mobile apps for spatial data[1,2,3], and more specifically for natural disasters management, is emerging [4,5,6,7]. In the research field of wildfire management, mobile GIS apps contribute in several different aspects of wildfires, such as forest fuels measurement[8,9], real-time alertness though text messages [10] and conduction of fire behavior simulations through mobile applications in the Cloud [11]. However, only few mobile apps are available for operational use; e.g. the Alberta Wildfire[12], European Forest Fire Information System App[13], Forest Fire Danger Meter[14] and Wildland Fire Behavior App[15]. It is remarkable that the aforementioned apps have been published only in the Google Play app store and/or the Apple store; none of these apps is yet available for Windows Phone devices. The AEGIS App tries to fill this gap, since it has been implemented as an application for native Windows Phone devices. Next versions are planned to be implemented for Android and iPhone devices, as well. Additionally, interaction of end-users and the mobile device through text typing and filling of forms is not an easy task, especially during a fire emergency. AEGIS App confronts this shortcoming with the utilization of the digital assistant for artificial intelligence Cortana that allows the operation of desired functionalities through voice commands.

2. The AEGIS App

The AEGIS App has been developed and applied for seven different study locations spread out over Greece with high-hazard, high-value and high-use forest and other multi-purpose areas. The app has been designed to work in cooperation with the web-based platform of AEGIS, allowing sharing of information, data and functionalities between them. Upon opening of the AEGIS App, the current location of the end-user is tracked (received from the GPS sensor of the device) and is visualized as a fire vehicle symbol on top of the background mapping schemes (i.e. Bing Maps or Open Street Maps) (Figure 1a). Underneath the map, several options and icons exist that provide access to different functionalities:

- The *Fire Data* icon provides access to fire management data, such as the locations of the water tanks, pumping stations, fire hydrants, RAWS, fire watch outlooks, fire vehicles on-duty, helipads, landfills, evacuation sites, gas stations, cultural monuments and the road network of the area.
- The *Position* icon that re-calculates the current position of the end-user and re-centers the background map.
- The *Weather* icon that provides access to the current weather conditions; i.e. air temperature (ºC), relative humidity (%), wind speed (m/sec), wind direction (degrees) and precipitation (mm) retrieved from the nearest RAWS (Figure 1b).
- The *Directions* icon that enables the calculation of the shortest route between the current location and a different location specified by the user, based on the Bing Maps routing service[16].

Beyond these options, the *Change Basemap* dialog enables to switch the base map scheme between Bing Maps and Open Street Maps. The option *Clear Map* clears the base map from any previously loaded data, while the *Login* option enables end-users to login as authenticated users, thus, allowing them to publish a new wildfire event in the web-based platform of AEGIS.

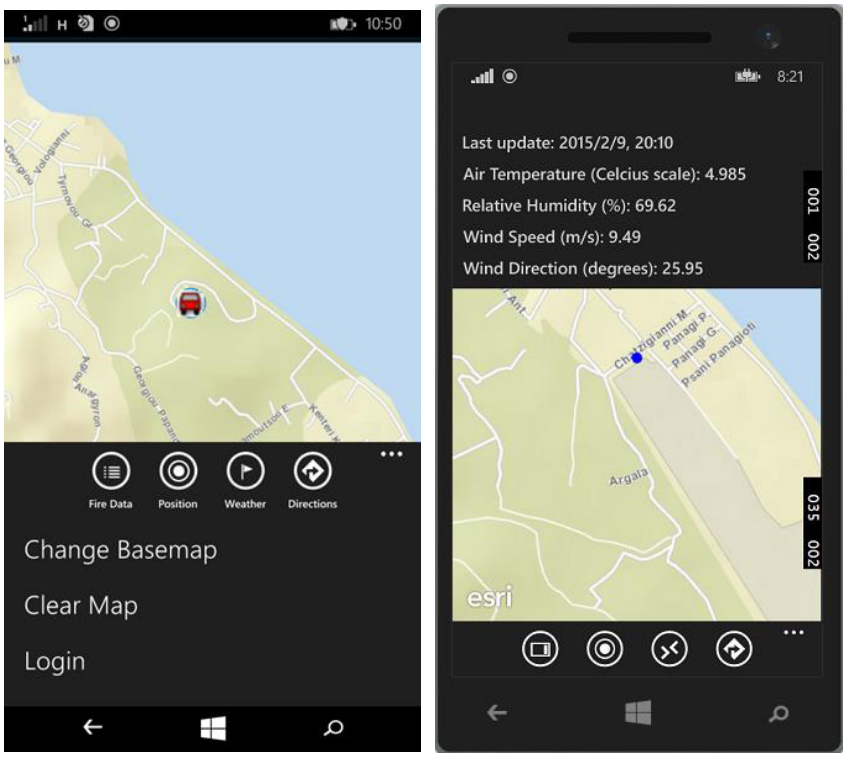

Fig. 1. (a) Basic screen of AEGIS App; (b) access to current weather conditions.

The first available tool from the *Fire Data* icon is the *Drive Times* tool. The tool enables the calculation of the areas that the user can access by driving a regular firefighting truck in 3 minutes, in 5 minutes and in 10 minutes, starting from the current location. The road network has been categorized into different classes (highways, primary, secondary, forest, unpaved, agricultural and urban roads). Length and travel time for each road network segment has also been calculated, taking into consideration the road class and topographic slope. The *Closest Facilities* category uses similar datasets and enables the calculation of the routes to the closest water tanks, pumping stations and fire hydrants, while each route is visualized by a different color. Both *Closest Facilities* and *Drive Times* tools were published as geo-processing services with the support of the ESRI ArcGIS API[17]running in a dedicated server. The Fire Management category visualizes the locations of several fire management data, published also in ArcGIS Server as mapping service.

AEGIS App provides even greater convenience for accessing desired data and services by utilizing the Cortana digital assistant [18]. Cortana is a highly advanced artificial intelligence system for the Windows Phone platform. It allows end-users to execute the desired functions via their mobile phone, simply by using corresponding voice commands. The voice commands are executed in an automatic and transparent to the user way and the result is visualized on the screen of the mobile phone without any further user intervention. If AEGIS App is opened, the desired tasks cannot be accomplished through the voice commands because Cortana cannot be utilized simultaneously with an opened application.

All of the available voice commands are initialized with the word "AEGIS". This enables Cortana to "understand" that the following phrases should be assigned to AEGIS App. The voice commands supported by the application are the following:

- "*AEGIS Open water tanks"* for the visualization of water tanks.
- "*AEGIS Open pumping stations*" for the visualization of pumping stations.
- "*AEGIS Open fire hydrants*" for the visualization of fire hydrants.
- "*AEGIS Open closest water tanks*" for the calculation of the routes of the three closest water tanks from the current end-user's location.
- "*AEGIS Open closest pumping stations"* for the calculation of the routes of the three closest pumping stations from the current end-user's location.
- "*AEGIS Open closest fire hydrants"* for the calculation of the routes of the three closest fire hydrants from the current end-user's location.
- "*AEGIS Open drive times"* for the calculation of the area that a firefighting truck can reach in 5, 10 and 15 minutes, starting from the current end-user's location.
- "*AEGIS Open road network*" for the visualization of the road network.

3. Discussion and Conclusions

This work describes an innovative mobile application for wildfire information management that operates on Windows Phone devices and acts as a complementary tool to the web-based version of the AEGIS platform for wildfire prevention and management. To the best of our knowledge, AEGIS App is the first mobile application for wildfire information management that is available for Windows Phone devices. Several tasks can be accomplished, such as routing, spatial search for closest facilities and firefighting support infrastructures, access to weather data and visualization of fire management data. The usability of the application is further enhanced by utilizing the digital assistant of Cortana that allows the operation of desired functionalities through voice commands.

The combination of the web-based version of the AEGIS platform[19] with the AEGIS App will provide access to key services of fire management, especially to the operational end-users at the front line. In case of a fire emergency, end-users at the field can now utilize the mobile app and the location of the fire is directly incorporated in the graphical interface of the web platform of AEGIS (Figure 2). The web platform of AEGIS offers services beyond simple coordination of emergency activities. Remote automatic weather stations and a weather forecasting system based on the SKIRON/ RAMS weather model provide crucial data needed for fire prevention and early warning. Geographical visualization of the fire risk potential and identification of high-risk areas for the next five days at different local regions will be provided daily, based on parallel computing processing techniques. This can improve significantly the current qualitative fire risk estimation methodologies provided and come up with a first attempt of a quantitative Fire Danger Rating System in Greece. This is due to state-of-the-art and innovative geo-spatial tools being utilized for fire danger estimation; while the fire behavior prediction algorithm of Minimum Travel Time (MTT) algorithm[20] is used either for single fire propagation or for stochastic fire behavior modeling, resulting in maps of conditional burn probabilities and flame length.

In Figure 2, the potential exploitation of a parallel utilization of the web platform from fire firefighting headquarters and the mobile app from the field is portrayed. After the details of the new wildfire event have been published though the AEGIS App (Figure 2a-b), the wildfire location can be directly visualized over the web platform's graphical interface. With the provided innovative tools, local authorities can design an operational plan to confront the forest fire. Real-time wind parameters (speed and direction) can be retrieved from the closest RAWS and used for wildfire simulations with MTT, while multiple on-demand simulations can also be conducted by changing the weather parameters and simulate different "what if" scenarios. Upon the completion of a simulation, all outputs (flow paths, fireline intensity, rate of spread and time of arrival) can be directly visualized over the AEGIS platform by enabling a checkbox next to each mapped attribute (Figure 2c). Individual output files can also be downloaded as .kml layers or alternatively, can be downloaded in their raw format as a zip file. Next versions of the AEGIS App will provide end-users with the ability to perform simulations from their device, and visualize the results of the fire behavior directly in their mobile device.

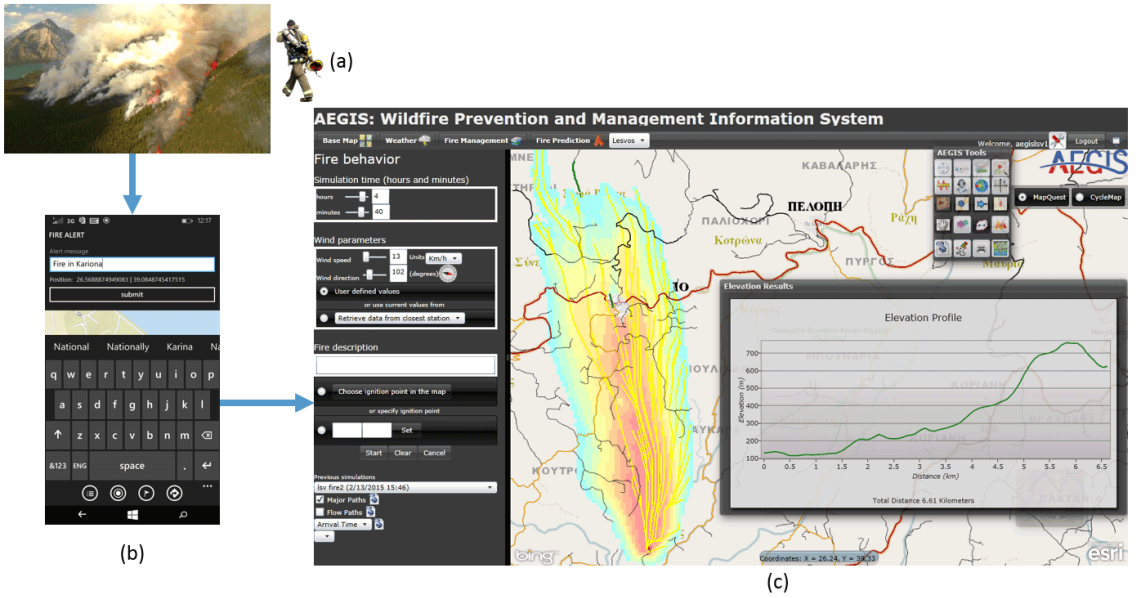

Fig.2. Parallel utilization of the web-based platform and the mobile app of AEGIS.

Acknowledgements

This work has been supported by the research project "AEGIS: Wildfire Prevention and Management Information System" {Code Number 1862}, implemented within the framework of the Action ARISTEIA of the Operational Program "Education and Lifelong Learning" (Action's Beneficiary: General Secretariat for Research and Technology), and is co-financed by the European Social Fund (ESF) and the Greek State.

References

1. Freire, C. E., Painho, M. Development of a Mobile Mapping Solution for Spatial Data Collection Using Open-Source Technologies. *Procedia Technology,* 16, 481-490; 2014.
2. Döner, F. Examination and comparison of mobile GIS technology for real time geo-data acquisition in the field. *Survey Review,* 40(309), 221-234; 2008.
3. Tsou, M. H., Sun, C. H. Mobile GIServices applied to disaster management. Dynamic and mobile GIS: investigating changes in space and time (innovations in GIS, 213-236; 2006.
4. Mansourian, A., Farnaghi, M., Taleai, M. Development of new generations of mobile GIS systems using Web services technologies: A case study for emergency management. Journal of Applied Sciences, 8(15), 2669-2677; 2008.
5. Baldegger, J., Giger, C. Wearable GIS: A Smart Assistant in Disaster Management. In: AGILE 2003: 6th AGILE Conference on Geographic Information Science. PPUR presses polytechniques; 2013. p. 19.

6. Wu, X., Mazurowski, M., Chen, Z., Meratnia, N. Emergency message dissemination system for smartphones during natural disasters. In: ITS Telecommunications (ITST), 2011 11th International Conference on. IEEE, p. 258-263; 2011.
7. Fajardo, J. T. B., Oppus, C. M. A mobile disaster management system using the android technology. WSEAS Transactions on Communications, 9(6), 343-353; 2010.
8. Ferster, C. J., Coops, N. C., Harshaw, H. W., Kozak, R. A., Meitner, M. J. An Exploratory Assessment of a Smartphone Application for Public Participation in Forest Fuels Measurement in the Wildland-Urban Interface. *Forests,* 4(4), 1199-1219; 2013.
9. Ferster, C. J., Coops, N. C. Assessing the quality of forest fuel loading data collected using public participation methods and smartphones. *International journal of wildland fire,* 23(4), 585-590; 2014.
10. Davies, D. K., Vosloo, H. F., Vannan, S. S., Frost, P. E. Near real-time fire alert system in South Africa: from desktop to mobile service. In Proceedings of the 7th ACM conference on designing interactive systems; 2008. pp. 315-322.
11. Mancini, E., Wainer, G., Al-Zoubi, K., Dalle, O. Management of Simulation in the Cloud Using Handheld Devices, 12th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing; 2012.
12. Alberta Wildfire [Online]. Available: https://itunes.apple.com/ca/app/alberta-wildfire/id626977403?mt=8 and https://play.google.com/store/apps/details?id=ca.ab.gov.ABWildfire [Accessed 29 April 2015]
13. European Forest Fire Information System (EFFIS) App. Available: https://itunes.apple.com/us/app/effis/id947823675?mt=8 [Accessed 29 April 2015]
14. Forest Fire Danger Meter [Online]. Available: https://play.google.com/store/apps/details?id=appinventor.ai_firemanal.ForestFireDangerMeter [Accessed 29 April 2015]
15. Wildland Fire Behavior App. Available: https://play.google.com/store/apps/details?id=appinventor.ai_chris_moran0124.WildlandFireBehaviorApp [Accessed 29 April 2015]
16. Sinani, A. Learning Bing Maps API, Packt Publishing; 2013.
17. ArcGIS API [Online]. Available: https://developers.arcgis.com/silverlight/ [Accessed 29 April 2015]
18. Lison, P., Meena, R. Spoken dialogue systems: the new frontier in human-computer interaction. XRDS: Crossroads. The ACM Magazine for Students, 21(1), 46-51; 2014.
19. Kalabokidis K., Vasilakos C., Athanasis N., Palaiologou P., Tsekouras G. Wildfire Prevention and Management Information System (AEGIS). Proceedings of National Conference on "New Technologies in Prevention and Management of Natural Disasters – The Role of Civil Protection", 24-26 October 2014, Rhodes, Greece. Organizer Municipality of Rhodes, 13 p; 2014.