Designing AR viewer for QField: towards supporting handling geospatial data in situ for emergency response situations

Anton Fedosov [a,*], Elif Gürçınar [a], Luca Fluri [a], Marco Bernasocchi [b], Matthias Kuhn [b], Arzu Çöltekin [a]

[a] *Institute for Interactive Technologies, University of Applied Sciences and Arts Northwestern Switzerland (FHNW), Anton Fedosov - anton.fedosov@fhnw.ch, Elif Gürçınar - elif.gurcinar@fhnw.ch, Luca Fluri - luca.fluri@fhnw.ch, Arzu Çöltekin - arzu.coltekin@fhnw.ch*
[b] *OPENGIS.ch GmbH, Marco Bernasocchi - marco@opengis.ch, Matthias Kuhn - matthias@opengis.ch*

* Corresponding author

Keywords: fieldwork, GIS, augmented reality, disaster management

Abstract:

GIS tools ubiquitously employ maps to aid visualization of the geographically referenced information (geo-data) across diverse disciplines, including civil engineering, forestry, geology, ecology, and archaeology. In this applied science project, we collaborated with OpenGIS.ch, a company that developed QField (https://qfield.org), an award-winning mobile tool to collect, manage, and edit geo-data in situ tailored to the needs of the GIS fieldwork. Beyond traditional uses in civil engineering, such as construction, urban planning, and infrastructure work, QField has also been employed to facilitate disaster management and recovery tasks. For example, it has been used in mapping flooding damage to houses, infrastructure and vehicles in Canton Ticino, Switzerland in 2024 (Bernasocchi, 2024), assessing flooding damage of the croplands in Fiji (Duncan et al., 2022), as well as monitoring the (agricultural) recovery of the damaged lands and infrastructure in Tonga due to a volcano eruption (Davies et al., 2019; Saipaia, 2022).

However, despite its interoperability (QField is based on a popular QGIS open-source project https://www.qgis.org), several challenges remain in rendering and interacting with geospatial data in situ. Specifically, interactions using the current mobile/tablet app are constrained to the manipulation of 2D data points on the map interface (Figure 1), which can often cause issues such as overplotting and occlusion (Amini et al., 2014) or are prone to difficulties in spatial interpretation and decision-making processes (Safari Bazargani et al., 2022).

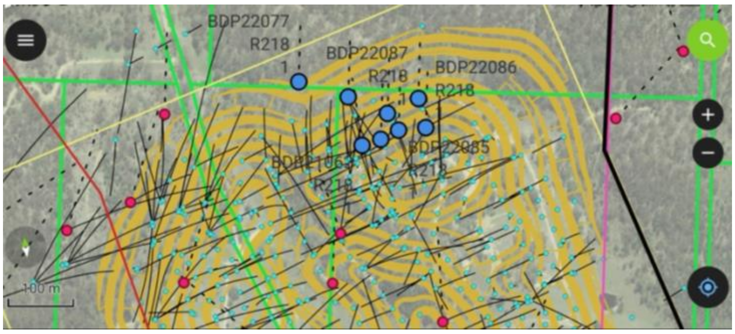

Figure 1. A screenshot from the QField app of the community project "2022_Drill_Planning" published by BowdensSilver.

To address the above-mentioned challenges of user perception and interaction and take advantage of the strengths of both 2D and 3D visualizations, we propose an *Augmented Reality (AR) viewer for Qfield*. By implementing AR, we enable the placement and rendering of 3D geo-data in situ. Previous research shows mixed evidence regarding the usefulness and usability of the advantage of 3D visualizations in AR for understanding statistical data, local topography, and reading maps (de Almeida Pereira et al., 2017; Hegarty et al., 2009; McIntire et al. 2014, Ambühl, 2022; Çöltekin et al., 2016). We believe, in this case, the AR viewer will facilitate the efficiency of decision-making in the field by visualizing relevant geo-data in the immediate real-world environment, supporting various field tasks from planning underground utilities beneath the surface (Hansen et al., 2021; Fenais et al., 2019) to virtual demarcation of the forecasted flood territories. We aim to design and develop an AR viewer for QField for both handheld and wearable

AR experiences to support a broad range of tasks and enhance interactivity with geo-data and real-world immersion, thus improving spatial understanding and decision-making in situ. A specific strength of the AR in this case is to display the relevant information in its spatial context, which we hypothesize should facilitate quicker comprehension of the situation, as it offers an *experience-based* approach rather than strictly an *analytical* one.

For this work-in-progress project, we explore the AR requirements and demands of field workers, not only in mainstream use cases such as civil engineering or geology but also in disaster management and response scenarios. We plan to gather feedback from the geovisualization, cartography, and environmental science experts and disaster management community to inform the design and implementation of the geospatial AR viewer for QField to support decision-makers when it comes to forecasting, preparing, and responding to disasters.

The contribution of our work is threefold: (1) we elicit the AR needs of field workers when it comes to in situ interactivity with geospatial data; based on these needs (2) we design and develop an interactive prototype of the AR viewer for QField; and through continuous user evaluations (3) we examine how data points in AR can be represented across different form factors, such as handheld and wearable AR, by referencing scholarly discussions on the visualization of 2D vs. 3D data for both experiential and analytical tasks (Hegarty et al., 2009, McIntire et al. 2014, Ambühl, 2022; Çöltekin et al., 2016).

Acknowledgements

This project has been supported by the Swiss Innovation Agency (Innosuisse), project Nr. 74306.1 INNO-ICT.

References

Amini, F., Rufiange, S., Hossain, Z., Ventura, Q., Irani, P. and McGuffin, M.J., 2014. The impact of interactivity on comprehending 2D and 3D visualizations of movement data. *IEEE transactions on visualization and computer graphics, 21*(1), pp.122-135.

Ambühl A., Fluri L., Zucker C., Goodman A., and Çöltekin A. 2022. Effectiveness and perceived usefulness of a handheld AR cube for examining 3D spatial structures. In *SpaceCHI 2.0 Workshop at ACM CHI 2022*.

de Almeida Pereira, G.H., Stock, K., Stamato Delazari, L. and Centeno, J.A.S., 2017. Augmented reality and maps: New possibilities for engaging with geographic data. *The Cartographic Journal, 54*(4), pp.313-321.

Bernasocchi, M. 2024. Rapid Mapping the Ticino Floods and Landslides with QField Rapid Mapper. Retrieved September 20, 2024 ,from https://www.opengis.ch/2024/07/07/qfield-rapid-mapping-ticino/

Çöltekin, A., Lokka, I., and Zahner, M. 2016 On the usability and usefulness of 3d (geo)visualizations – A focus on virtual reality environments. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci*., XLI-B2, 387–392, https://doi.org/10.5194/isprs-archives-XLI-B2-387-2016.

Davies, K.P., Duncan, J., Wales, N., Varea, R., Shojaei, H., Bruce, E., Boruff, B. and Biggs, E., 2019. An open-source mobile geospatial platform for promoting climate-smart livelihood-landscape systems in Fiji and Tonga. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *42*, pp.31-36.

Duncan, J., Varea, R., Boruff, B., and Davies, K. 2022. Detecting flooding in Fiji's croplands. Climate Change AI. https://www.climatechange.ai/blog/2022-09-06-grants-fiji-flood

Hansen, L.H., Fleck, P., Stranner, M., Schmalstieg, D. and Arth, C., 2021. Augmented reality for subsurface utility engineering, revisited. *IEEE Transactions on Visualization and Computer Graphics, 27*(11), pp.4119-4128.

Hegarty, M., Smallman, H. S., Stull, A. T., & Canham, M. S. 2009. Naïve cartography: How intuitions about display configuration can hurt performance. *Cartographica: The International Journal for Geographic Information and Geovisualization*, *44*(3), 171-186.

Fenais, A., Ariaratnam, S.T., Ayer, S.K. and Smilovsky, N., 2019. Integrating geographic information systems and augmented reality for mapping underground utilities. *Infrastructures*, *4*(4), p.60.

McIntire, J. P., Havig, P. R., & Geiselman, E. E. 2014. Stereoscopic 3D displays and human performance: A comprehensive review. *Displays*, *35*(1), 18-26.

Safari Bazargani, J., Zafari, M., Sadeghi-Niaraki, A. and Choi, S.M., 2022. A survey of GIS and AR integration: applications. *Sustainability*, *14*(16), p.10134.

Saipaia, A. 2022. Livelihoods and landscapes - Hunga Tonga-Hunga Ha'apai Volcanic eruption. Livelihoods and Landscapes. Retrieved September 6, 2024, from https://livelihoods-and-landscapes.com/examples/hunga-haapai/hunga-haapai.html