Gozo 3D Immersion: Reality-to-Virtual Framework

SAVIOUR FORMOSA

Environmental Monitoring and Reporting Tools

Malta is required to adopt various national and international tools that are transposed into legislation, which tools aid the setting up of data-cycles for use in monitoring and reporting, particularly with regard to the environment. In turn, such tools can help users to familiarise themselves with the real spatial surroundings, to understand the data available and also to create scenarios that aid users to interact with others online. This would also help users to 'know' their spaces even when they are not physically present in these same places.

One may consider it ironic that we are creating virtual worlds, when one can easily take a stroll down a hill to experience the real thing: technology seems to be diluting one's quest for real knowledge. However, information and communication technology is essential as it is leading to the development of new tools for environmental protection. Failing to prepare society for the inevitable 'reality' of virtualisation is likely to lead to major disadvantages.

A Major Project on Transforming Reality into Virtuality

In order to initiate the conversion of the physical domain into the internet virtuality, a project was initiated in 2009, entitled Developing National Environmental Monitoring Infrastructure and Capacity (MEPA, 2009). The project involved the monitoring of air, water, soil, radiation, noise and the marine environment. It also sought to acquire 3D terrestrial and bathymetric surveys. This project was co-financed by the European Regional Development Fund (ERDF), which provided 85% of the project's funding and the Government of Malta, which financed the rest under Operational Programme 1 - Cohesion Policy 2007-2013 - Investing in Competitiveness for a Better Quality of Life, which also ensured the free dissemination of the project's resultant data.

This project was preceded by three years of ground-setting exercises, conducted by experts in various environmental and technological fields. The scope of the project was to identify modes of baseline data capture across the domains, aimed at the enhancement of integrated data and the eventual porting to online virtual worlds. This was made possible through an analysis of the state of affairs relating to data access, harmonised datasets and validated data.

Although this exercise was highly supported by EU funds, it required major Maltese initiatives at the national level and technical inputs by individual researchers and legislators. The project led to important advances in technological and analytical processes with societal benefits, as identified by the GEO initiatives (GEO, 2014).

The GEO initiative focuses on:

- Reducing loss of life and property from natural and human-induced disasters;
- Understanding environmental factors affecting human health and well-being.
- Improving management of energy resources;
- Understanding, assessing, predicting, mitigating, and adapting to climate variability and change;
- Improving water resource management through better understanding of the water cycle;
- Improving weather information, forecasting and warning;
- Improving the management and protection of terrestrial, coastal and marine ecosystems;
- Supporting sustainable agriculture and combatting desertification; and
- Understanding, monitoring and conserving biodiversity.

The first steps of this project sought an understanding of the reality on the ground as well as the implementation of various legislative tools. These included those relating to the implementation of the Aarhus Convention (OJ, 2003a), the INSPIRE Directive (OJ, 2007), the Freedom of Information Act (Government of Malta, 2012), Public Access to Information Act (OJ, 2003b), and the Shared Environmental Information System (SEIS, 2014). However, these tools, by themselves, were of little help to the public at large to access and understand the data and further work was needed in this regard.

Creating Baseline Data

The project ensured that a new set of baseline data was created from which to launch Malta's data capturing exercises across the different themes. Terrestrial and bathymetric data were made available at a high degree of resolution suitable for environmental modelling and EU reporting purposes.

The delivery included high resolution 3D terrestrial data coverage for the Maltese Islands using a combination of oblique aerial imagery and Light Detection and Ranging (LIDAR) data, as well as a bathymetric survey of coastal waters within a one nautical mile (nm) radius off the baseline coastline, using a combination of aerial LIDAR surveys, acoustic scans and a physical grab sampling survey. These technologies, as well as other fieldwork technologies, have equipped the researchers with a launching pad for the diverse physical, environmental and social studies that are undertaken in relation to the strengthening of social and environmental health.

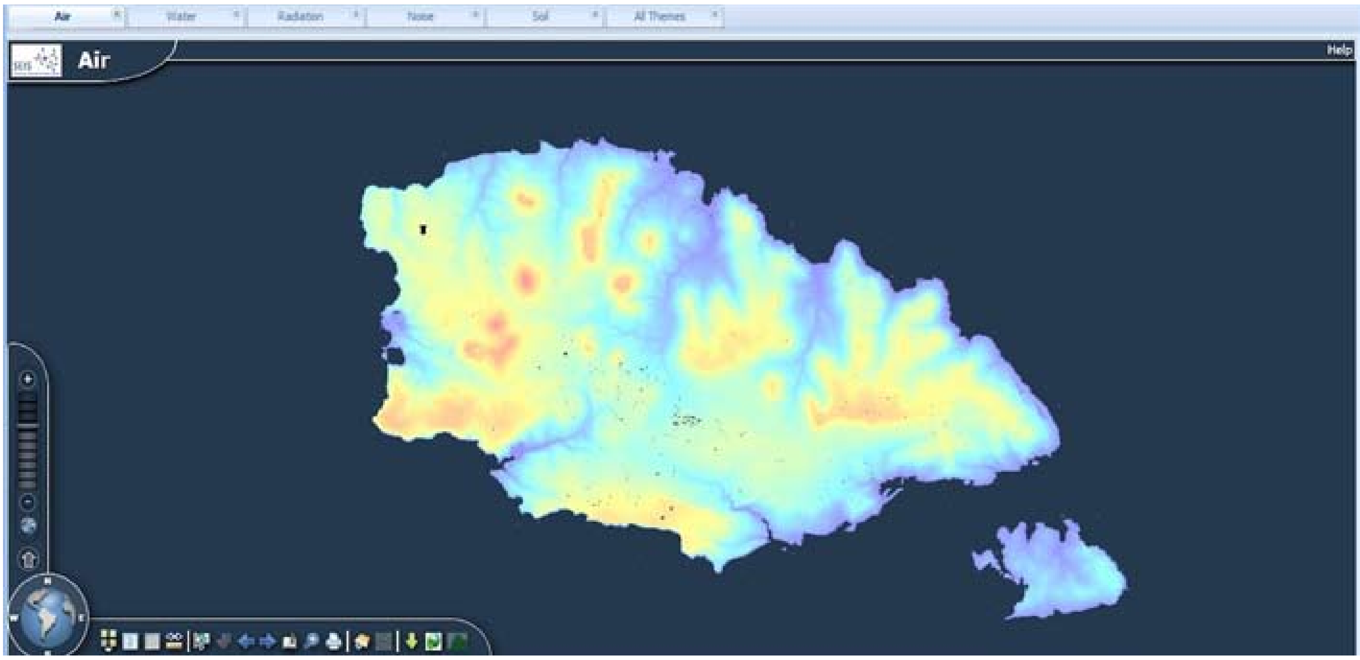
The 3D aerial surveys using LIDAR technology surveys can be used for various applications such as urban and transport planning, environmental impact assessments, modelling of runoff water, monitoring of and enforcement of landuse activities. In the case of this project, veritable advances were made to transform a real place into the virtual world. The resultant terrain 3D models and the bathymetric 3D models are being merged to form an innovative integrated 3D perspective for the Maltese Islands. All data from this project was also planned to be made viewable from a web portal, known as a Shared Environmental Information System (SEIS) available at www.seismalta.org.mt.

Relevance of the Project for Gozo

The project has major implications for Gozo, enabling various features of the island to be converted from the real to the virtual world. This entails the depiction of imagery and spatial data in an integrated technology, some yet to be developed. The SEIS portal allows the dissemination of the data on the environment themes as well as a digital elevation model and other spatial information. Figure 1 depicts one outcome of this dissemination effort.

The project has yet to produce a dissemination tool for immersive 3D technologies that allow

Figure 1: SEIS portal

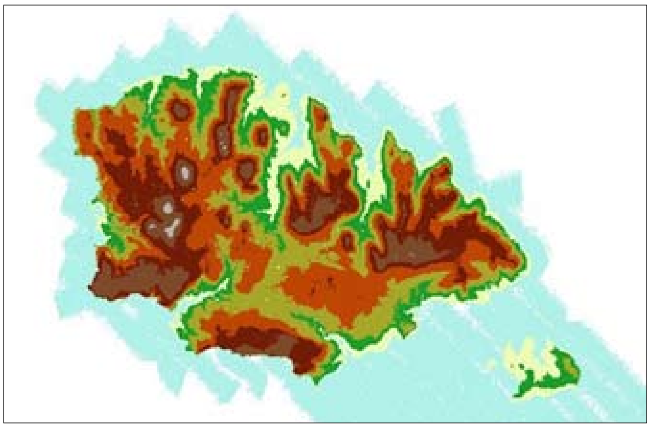


An image from the SEIS portal.

Figure 2: Satellite image of Gozo

This image can be overlaid onto the digital data providing a visual tool to serve as a reference point.

Figure 3: A Terrestrial Map of Gozo



A terrestrial map of the island at 1 point per 25cm, allowing for high resolution generation of virtual terrain.

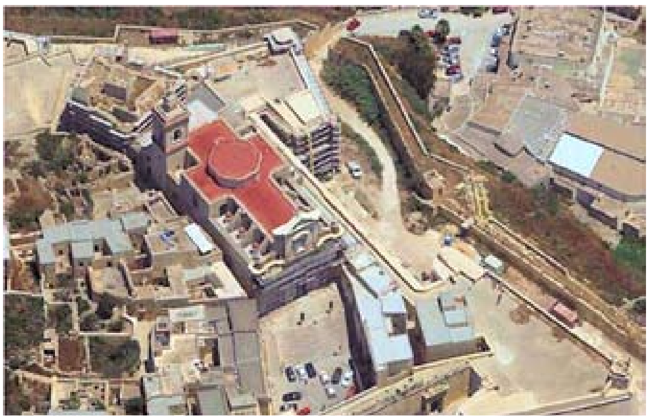
Figure 4: Bathymetric Map of Gozo

This bathymetric map enhances the analysis of the marine domain, mainly the submerged valleys to the north of Gozo.

for scenario building. This is currently being investigated through such tools as open source spatial information systems as well as affordable and readily accessible engines.

The initial experiments into this realm of investigation have resulted in interesting outcomes that would aid the real-world operators and the virtual-world explorers. Figures 2 to 5 depict the sequence of data capture processes that have established the baselines for high-end information structuring. Gozo now has a series of imagery that depicts remotely-sensed data, underwater datasets and imagery that shows building sides, which when

Figure 5: Oblique and Ortho imagery

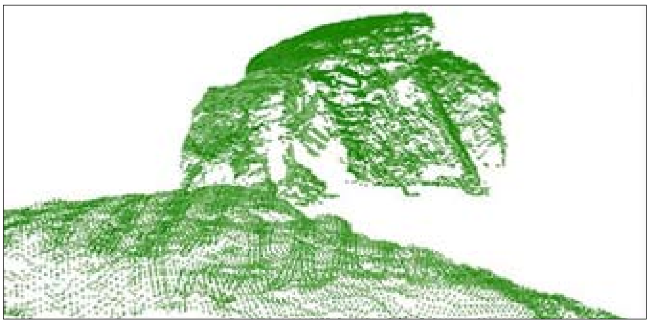


These imageries do not simply facilitate an analysis of the land from top-down but also sideways.

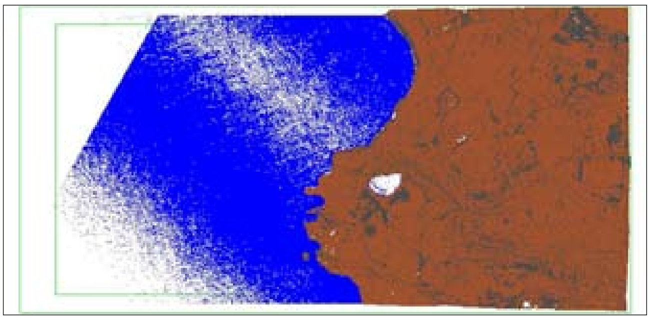
integrated, should prove essential for eventual porting to the virtual domain.

The capture of these datasets was a ground-breaking exercise that is expected to be integrated with the virtual world for scenario-building. Figures 6 consists of eight images that depict the detail that ensued in an analysis of the integration of three main datasets in the Dwejra area, namely (i) terrestrial LIDAR, (ii) bathymetric LIDAR and (iii) bathymetric sidescan sonar. In addition, the images also show a 3D output of

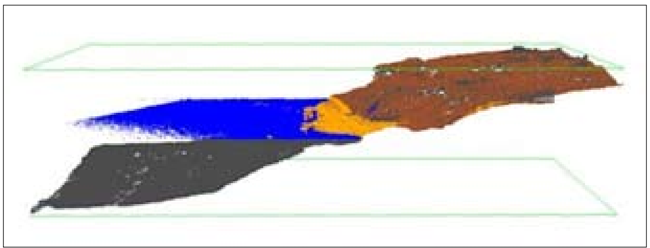
Figure 6: Progress Achieved In Integrative Exercise - The Dwejra Case Study



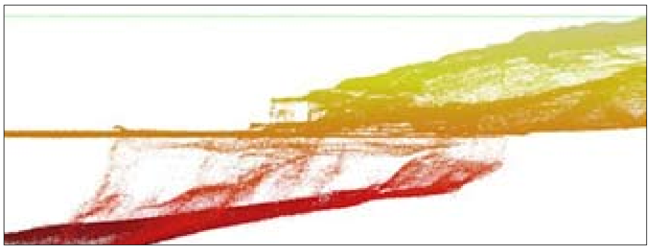
(a) Point Data extracted from the LIDAR scan.



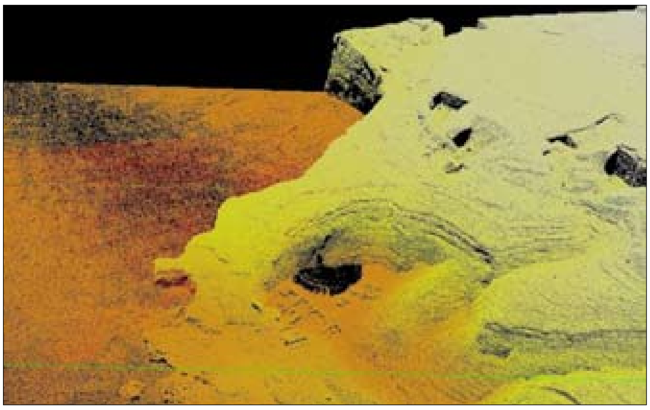
(b): Terrestrial and bathymetric data integration - top perspective.



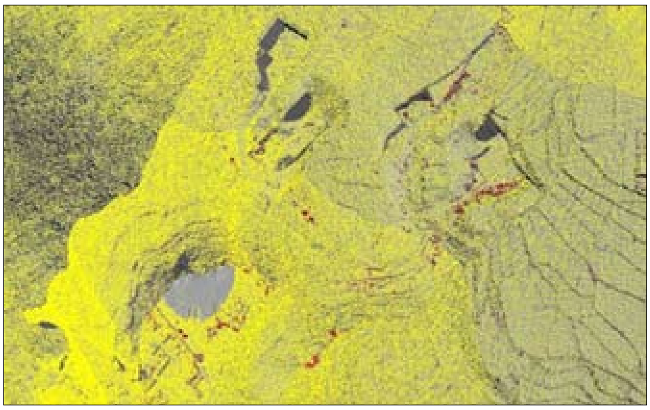
(c) Angled perspective of the three integrated datasets.



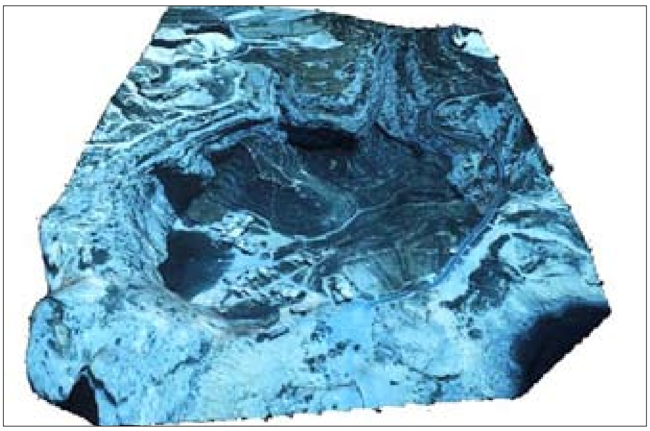
(d): Side perspective of the terrestrial and bathymetric data.



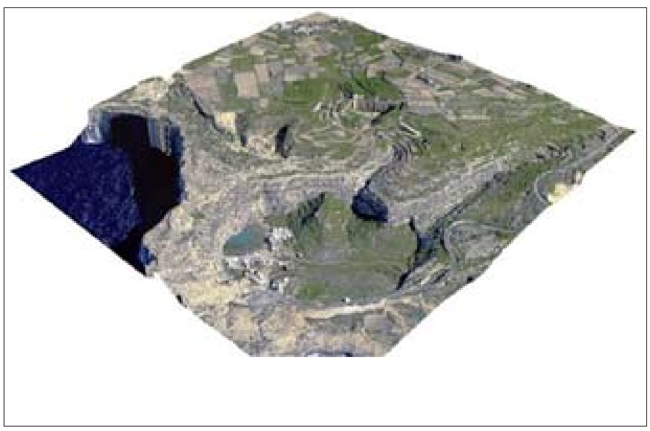
(e) LIDAR point data perspective, comprised of eight million points.



(f) Triangulated data depicting vegetation, buildings, quarries and other entities.



(g) 2004 overlaid image (aerial image overlaid on dem).



(h) 2014 integrated image (aerial image overlaid over LIDAR-data integrated vrml).

the data transposition for use by spatial planners. The images of Figure 7 depict the difference in resolution and clarity between the data that was available in 2004 and that available in 2014.

The Immersive Steps

The project results have been taken to the next step through the transposition of the LIDAR data into the social domain, where users can interact online within a 'familiar' space that they can relate to and in which they navigate their way. Away from the precursor Virtual Reality Modelling Language (VRML) that was difficult to use and rarely allowed for interaction, the new engines that have been developed for the gaming industry serve as the launching pad for immersive and social-interactive studies of life in the new worlds where the younger generations often operate. In addition, the new tools allow users to manipulate their space and in turn aid policy makers to morph their world in neo-geographic forms not available in the real world.

The engines utilised in this study are Minecraft and Unity3D, which are being experimented with. Some useful results have already been obtained with regard to their utility in place-recognition and scenario-building.

Figure 7, which contains four images, shows the results of the conversion of the Cittadella LIDAR data through raster mapping to a Minecraft world where users are able to fly around, walk within and interact in the virtual domain. These outputs are encouraging in that they provide users with various detailed levels with each block signifying a specific dimension. For example, each cubic block could be one of 10m, 1m or in this case 25cm, practically representing a real block of stone used in local building. Such a resolution allows for high-detail analytical work and scenario testing.

Figure 7: Cittadella Immersion Exercies (Minecraft world)

(a) Side perspective back.

(b) Side perspective front.

(c) Zooming in perspective.

(d) Immersive perspective.

Conclusion

The shift from the real to the virtual world is occurring at a rapid rate and the Gozitan analysis has shown that this technology can be harnessed for the benefit of society. The next steps would involve further developments relating to multi-thematics and cross-technology, which would allow further effective participation of the Gozitan society in matters that affect them, particularly those relating to the environment.

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