







the LiDAR for a road extraction algorithm where all points returned are within 0.5 of a meter, plus or minus, from the traversal surface.

Dimensions (m) – (length x width x height)	Time – average (s)	Points – average
20x0.1x1	0.3938	1481
20x0.3x1	1.0433	5921
20x1x1	2.6971	20677
20x5x1	9.9390	93170
20x20x1	36.2919	360936
20x40x1	82.4819	833445

Table 4. Timing results for 3D Box spatial query on the LiDAR database.

A plot of query time versus the varied width dimension for both 2D and 3D is displayed in figure 5. There are two important characteristics noticeable from this plot. First, there is a near linear relationship between the box objects dimension and the query time and secondly, the 3D query although more complex has a quicker execution time in all cases. We intend to demonstrate that by constraining the spatial query using a points attributes, such as amplitude and pulse width, we can reduce the time taken to return an optimised LiDAR point cloud containing only the required points for processing.

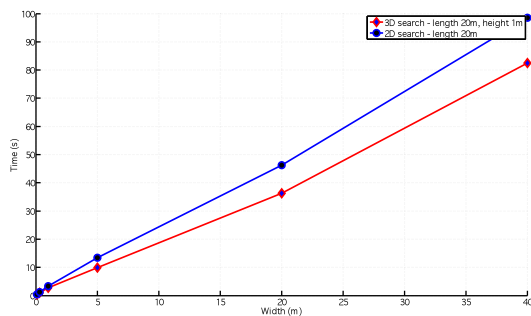


Figure 5. Graph plot for analyses of the timing results from table 1 and 2.

## 5. CONCLUSIONS AND FUTURE WORK

In this paper we have presented the initial stages of our development work towards a LiDAR-data management solution. Large volumes of point cloud data can be segmented geographically and/or based on non-spatial constraints. These could include user-defined constraints for the selection of specific point cloud attributes or algorithm constraints were data has to be segmented in a specific way. Ultimately these possibilities produce spatially optimised units targeted to a feature extraction algorithms requirements. While this work does not comprehensively define a complete DBMS LiDAR data handling solution it does provide the initial building blocks such that it has encouraged us to continue to pursue this research direction in both software development and hardware acquisition. Based on our requirements for a LiDAR-data spatial segmentation solution we have shown how a PostgreSQL database solution with PostGIS spatial extensions can be an efficient and effective platform for this work. Taking this work forward a number of issues remain to be tested. Firstly the point cloud I/O has not been fully analysed where we still have significant data intake issues; a solution to this is currently being implemented with initial testing showing large increases in performance. As has been shown, 3D queries are faster than the comparative 2D queries and as the framework matures and more bespoke LiDAR feature extraction algorithms

are added, we intend to show how further constraints on both 2D and 3D spatial queries can improve data segmentation and access times.

## ACKNOWLEDGEMENTS

Research presented in this paper was funded by a Strategic Research Cluster grant (07/SRC/I1168) by Science Foundation Ireland under the National Development Plan and by the ERA-NET SR01 projects. The authors gratefully acknowledge this support.

## REFERENCES

- Lewis, Paul, A. Stewart Fotheringham, and Adam Winstanley. 2010. Spatial Video and GIS. *International Journal for Geographical Information Science* In Press.
- Lewis, Paul, Adam Winstanley, and A. Stewart Fotheringham. 2009. Using ViewCones to Model Terrestrial Spatial Video. In *3D Geo-Information 2009*, Philippe De Maeyer, Tijs Neutens, and Marijke De Ryck, 149-158. Gent, Belgium: Gent University. <http://www.3dgeo.info.org/>.
- McElhinney, Conor P, Pankaj Kumar, Conor Cahalane, and Timothy Mccarthy. 2010. Initial results from European Road Safety Inspection (EURSI) mobile mapping project. In *ISPRS Commission V Technical Symposium, 2007*.. ISPRS.
- Nandigam, V, C Baru, and C Crosby. 2010. Database Design for High-Resolution LIDAR Topography Data. *Scientific and Statistical Database* 6187/2010: 151-159. doi:10.1007/978-3-642-13818-8\_12. <http://www.springerlink.com/index/X5Q937840983UN76.pdf>.
- PostGIS. 2001. PostgreSQL, PostGIS Spatial Extension. *Internet Source*. Refractions Research. <http://postgis.refractions.net/>.
- Rottensteiner, F, J Jansa. 2002. Automatic extraction of buildings from LIDAR data and aerial images. In: *International Archives of Photogrammetry, Remote Sensing XXXIV/4*, pp. 569-574.
- Schön, Bianca, Michela Bertolotto, Debra F. Laefer, and Seán W Morrish. 2007. Storage, Manipulation and Visualization Of Lidar Data. In *International Society Of Photogrammetry and Remote Sensing*. Trento, Italy: 3D-ARCH 2009. [http://www.isprs.org/proceedings/XXXVIII/5-W1/pdf/schoen\\_etal.pdf](http://www.isprs.org/proceedings/XXXVIII/5-W1/pdf/schoen_etal.pdf).
- Sharma, N., J. Parikh, and M. Clark. 2006. A Lidar Collaboratory Data Management System. *2006 IEEE International Symposium on Geoscience and Remote Sensing*: 817-820. doi:10.1109/IGARSS.2006.209. <http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=4241356>.