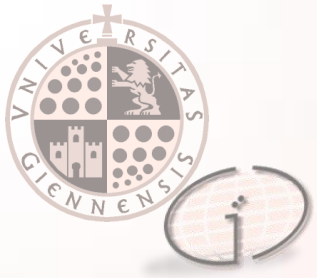

A proposal for obtaining 3D tracks based on multiple non-geodesic GNSS.

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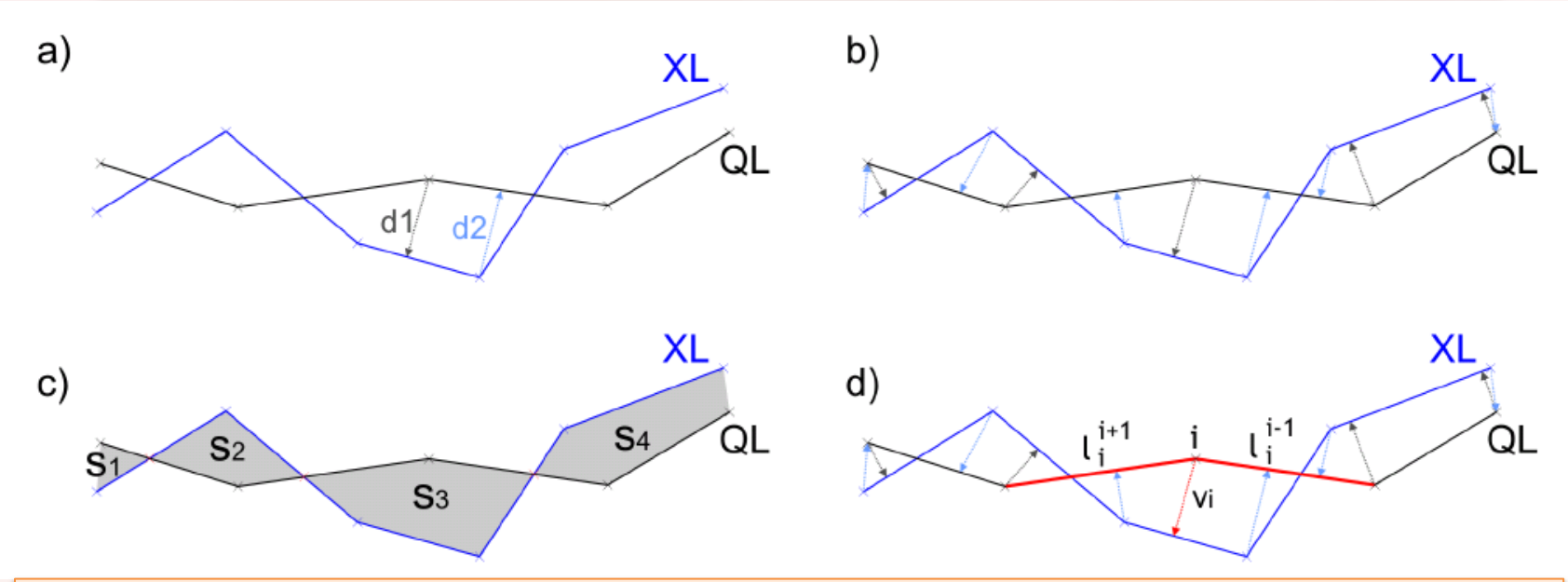
Introduction

Control Quality of 2D lines (Previous R&D Project)

Ministry of Science and Technology (Spain) and the European Regional Development Fund under grant no. BIA2003-02234



Mozas-Calvache, A. T.; Ariza-López, F.J.; Gil de la Vega, P. (2014): Metricas para el control posicional 3D de bases geoespaciales mediante elementos lineales. XVI Congreso Nacional de TIG.

A proposal for obtaining 3D tracks based on multiple non-geodesic GNSS.

Introduction

Control Quality of 2D lines

Increasing number of low cost GNSS devices

Producing cartography

Too much cartographic products, too fast, 3D

Can be used to control positional quality or update cartography?

Can we produce a service to provide positional quality control?

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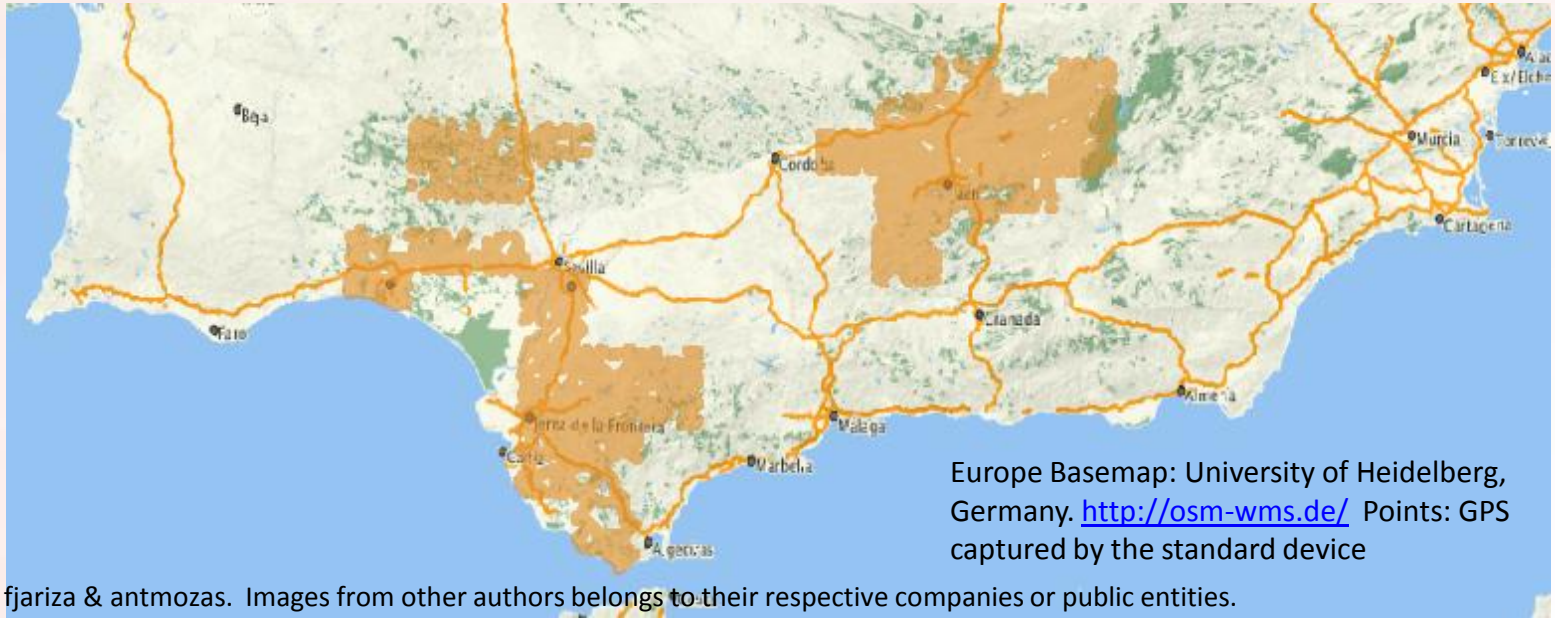
Introduction

R&D Project to control 3D positional quality

Ministry of Science and Technology (Spain) and the European Regional Development Fund under grant no. BIA2011-23217.

Dataloggers & Geodetic GNSS in moving cars simulating multiple users displacement

(> 150 M points)



Europe Basemap: University of Heidelberg, Germany. http://osm-wms.de/ Points: GPS captured by the standard device

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Premises for testing algorithm to obtain tracks from points

Select a test zone with aprox. 2M points from several devices.

Analyze existent methodology to reconstruct tracks.

Methodology based on different attributes all 2D.

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Material

Columbus V-900 (3 units).

1.5 meters precision / 1Hz.

Racelogic VBox GPS (+ IMU & - DGPS).

0.5 meters estimated precision / 100 Hz.

No restrictions about surveying
(allowing to stop, continue or cross through original paths).

Columbus V-900 image from: http://www.cbgps.com/v900/v900_index_en.htm
Vbox image from: http://www.velocitybox.co.uk/index.php/en/products/gps-data-loggers/38-vbox-3i-with-rtk

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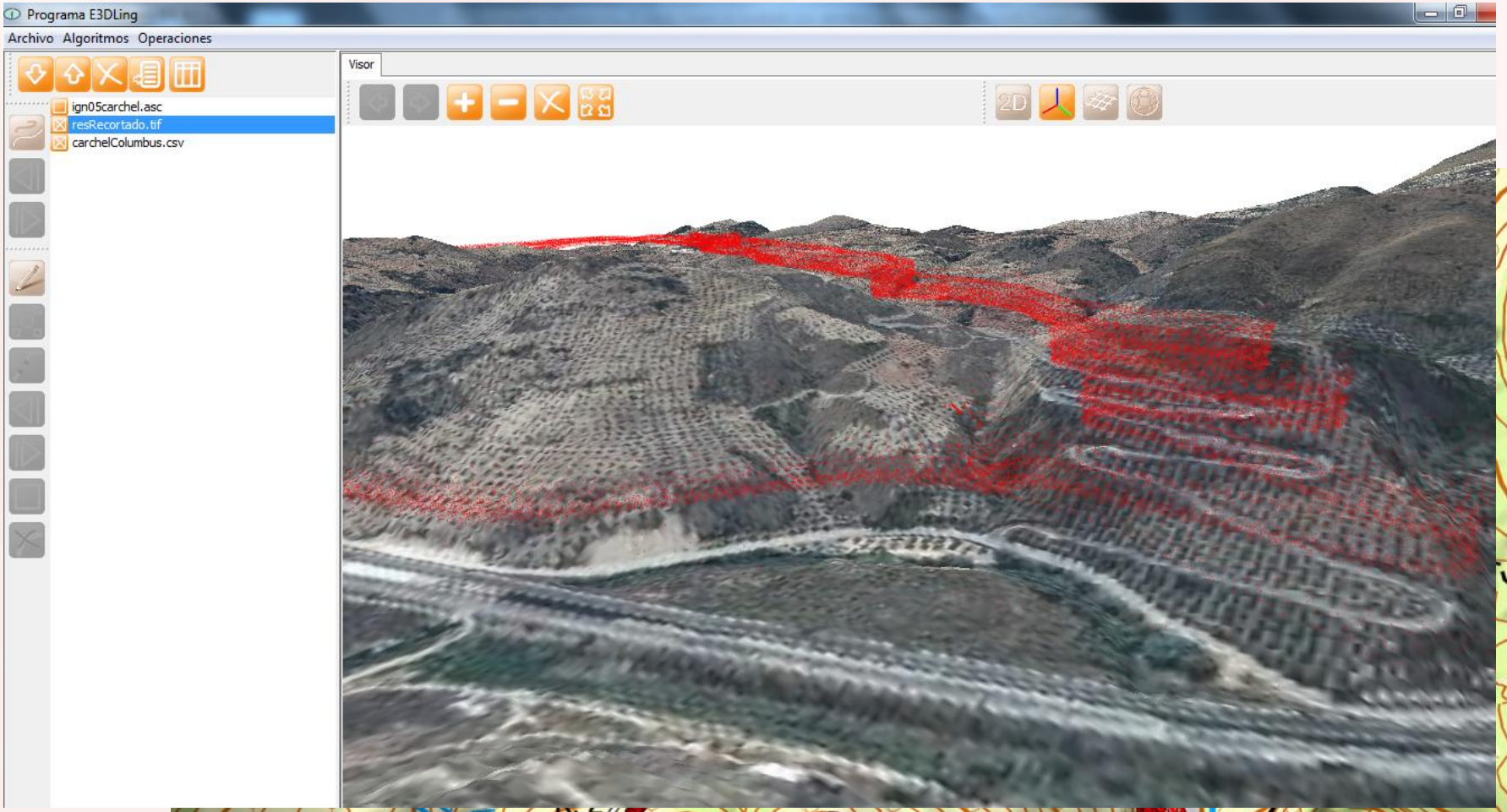
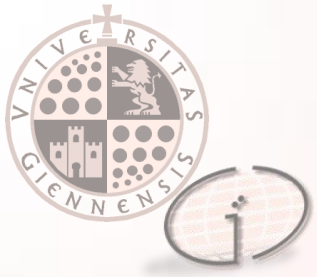
Test Zone



Europe Basemap: University of Heidelberg, Germany. http://osm-wms.de/ . Spanish Basemap: IGN Raster - http://www.ign.es/wms-inspire/mapa-raster?SERVICE=WMS& . Points: GPS captured by the standard device. 3D Map developed using own software.



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Brief review

Authors	Parameter	Values	Action
Agamenomi et al. (2010)	Delta time	3 seconds	Split track
	Max. dist. from other tracks	100 meters	Discard point(s)
Cao and Krumm (2009)	GPS prec. (min. attrac. dist)	5 meters	No action
Fathi and Krumm (2010)	Maximum delta time	10 seconds	Split track
	Speed	8 -145 km/h	Split track
	Distance between points	5 meters	Points interpolated to 5 meters
Lima and Ferreira (2009)	Minimum number of satellites	5 satellites	Discard point
	Maximum delta of time	7 seconds	Split track
	Min.dist. to trace (DougPe Alg)	1 meters	Discard all intermediate points
Liu et al. (2012)	Maximum speed	180 km/h	Discard last point
Niehöfer et al. (2010)	Min. dist. between points	5 meters	Merge point below threshold
	Maximum speed	200 km/h	Discard last point
	Acceleration	4 m/s^2	Discard point
	Direction change	Vel. function	Discard last point
Zhang et al. (2010)	Max. speed (highway/urban)	250/100 km/h	Discard last point
	Maximum distance	300 meters	Split track
	Maximum direction change	45º	Split track

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Methodology

Extract points and attributes from GNSS tracks.

Order points by timestamp.

Enrich information in a 3D space.

Remove points with no additional information.

Filter the points (Agamenomi et al.,2010; etc.)

Reconstruct tracks (Fathi & Krumm, 2010; etc.)

Maintain continuity of aligned tracks.

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Analysis & Discussion

Attribute Enrichment

- Increment of time
- Distance
- Velocity
- Angularity
- Acceleration
- Precision (PDOP /GPS satellites)
- **Increment of height**
- **Slope**

Remove points with null increment of time or distance

Less than 0.1%

Obvious correlations appears clearly: vel vs. dist, height vs. slope

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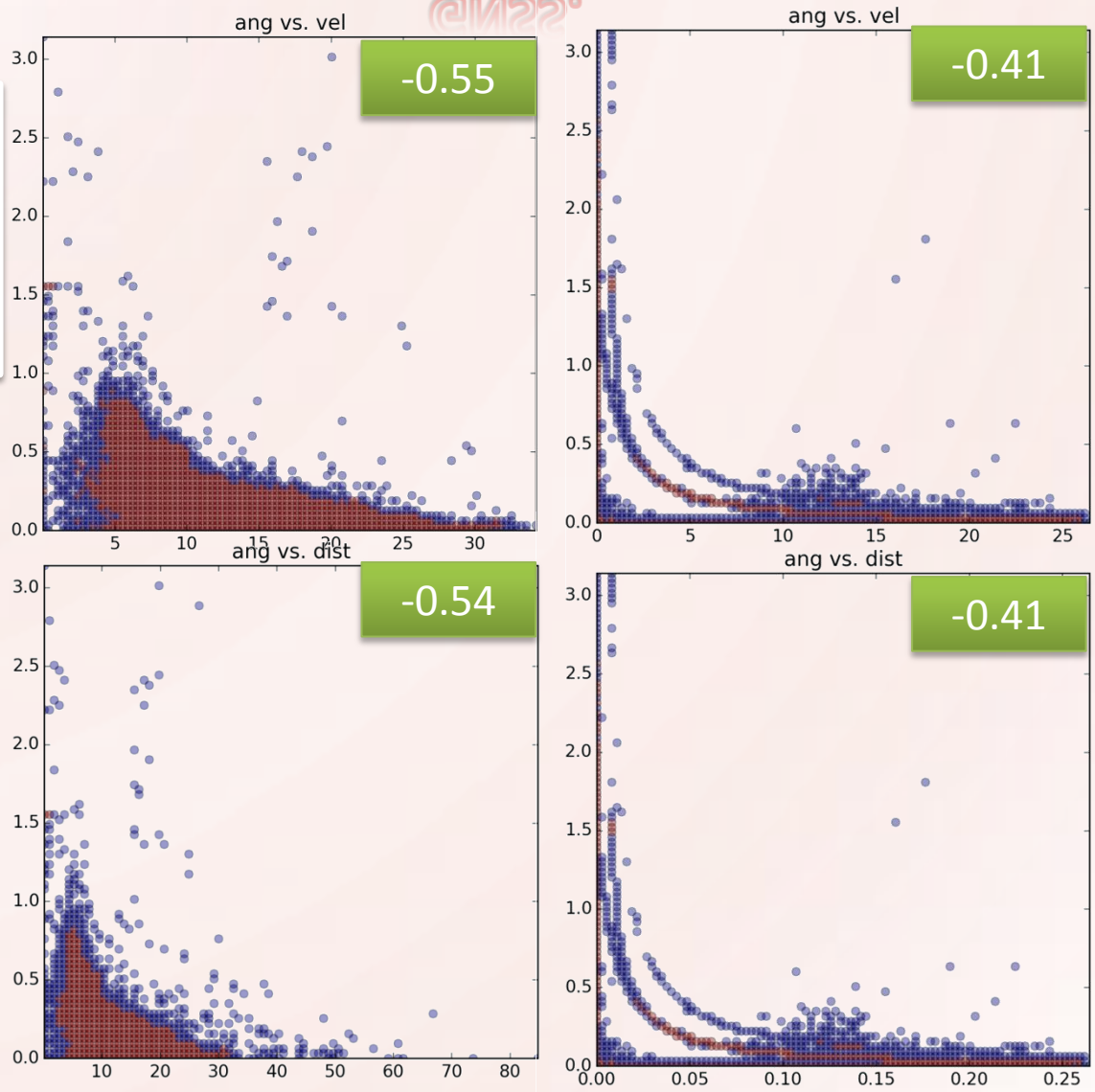
Analysis & Discussion

GPS data logger

Vbox + IMU data logger



Analysis & Discussion

Filtering points

Maximum distance: 100 meters (Agamenomi et al, 2010)

Acceleration: 4 m/s^2 (Niehöfer et al, 2010)

GPS precision, based on number of satellites with a minimum of 5 satellites (Lima & Ferreira, 2009).

Increment of time: from 1 to 3 seconds (previously used).

Differences between points in ascending and descending zones (no zero-slope). KS test (not height or time changes and slope).

Differences shown by KS test are lower than the range of values accepted for all the parameters (one set of parameters).

Recovering of points

Recover of points using Lima & Ferreira (2009).

1 meter in the normal direction.

No points recovered.

Distance too short and increasing this value should interfere with other parameters.

Reconstructed tracks

	Standard datalogger		VBox GPS	
	Pre-filtering	After filter	Pre-filtering	After filter
Max	72709.44	51393.73	122420.29	121871.29
Min	0.09	0.09	677.98	673.25
Mean	6467.68	3173.89	81663.17	61217.46
Number of tracks	287	576	3	4

Distances of reconstructed tracks in meters.

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Conclusions

Several approaches for filtering.	Similar correlated parameters (even 3D).
Correlation makes tuning threshold values difficult.	Suggest a set with low correlation.
Sinuosity and slope affect accel and angularity	Tracks cut (max. dist. correlated). No solution.
Algorithm to reconstruct tracks.	Based on previous (with Z dim). Useless (low values)

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