WOODTRANS

GPSTRACK

Assessment of GPS tracking devices and associated software suitable for real time monitoring of timber haulage trucks

PROJECT TEAM

Dr Kevin McDonnell, University College Dublin*
Dr Ger Devlin, University College Dublin
John Lyons, Coillte
Fionan Russell, Forest Industry Transport Group
Donal Mortimer, Shredwood Ltd.

*Email: kevin.mcdonnell@ucd.ie

COMPLETION DATE: October 2008

BACKGROUND

This project arises as a result of the recommendation in the *Code of Practice for Timber Haulage* launched in December 2004: *Encourage closer co-operation between consignors and hauliers to plan routes in a manner which optimises the economic returns within a legal framework.*

Initial research was carried out by the Forest Industry Transport Group (FITG) in 2002. Results showed that a substantial number of trucks (58-80%) are currently not adhering to the legal load restrictions. The enforcement of legal loading (44 t) will have a negative impact on revenue earned by hauliers (3-11%). Moving to a 40 tonne restriction will have a significant negative impact on the haulier's revenue (17-25%). The distance travelled unloaded (50%) is very high in many cases. Technology in the area of in-vehicle tracking systems has developed further since this initial research and such systems are now more economically viable and easier to access than before.

OBJECTIVES

- To study of the suitability, accuracy and efficiency of real-time GPS tracking of two timber haulage trucks travelling on public and forest roads. The GPS data will also be analysed in terms of its horizontal accuracy on the forest roads through the GIS.
- Results will be analysed and recommendations made to the haulage sector to determine whether GPS and GIS technology can be incorporated in a cost effective manner to help optimise the movements of timber trucks across Irish roads and within internal forest roads in terms of locating timber stockpiles.

PROGRESS

During the four week study period 10,669 data points were recorded for truck 1 and 9,500 data points recorded for truck 2. FMS engine diagnostic data were filtered from both data sets as it is not relevant to calculating GPS accuracy. After filtering, the amount of workable data to determine HRMS accuracy* were 8,360 and 5,049 data points for truck 1 and 2 respectively (Figures 1 and 2).

Figure 1: Public and forest road GPS tracklog created in GIS for Truck 1.

Figure 2: Public and forest road GPS tracklog created in GIS for Truck 2.

Table 1 and Figure 3 show that the HRMS 63% accuracy on the forest roads increases to as much as 41 m for truck 1 data and approximately 27 m for truck 2. The data for the public roads proves much more favourable with accuracy values of 2.55 m for truck 1 and 2.47 m calculated for truck 2. Results show that while the GPS accuracy vary considerably between public road data and forest road data (thus emphasising the effects of forest canopy) the tracking systems still work adequately to the point where the user can still monitor the movements of the trucks in real-time without the loss of much GPS and GPRS signal within the boundaries of the forests. The reasons for the difference are related to the position of the GPS receiver, but more importantly, due to the varying increased canopy of the forest from which truck 2 was transporting timber. Forest canopy has been well documented

* Horizontal Root Mean Square (HRMS) accuracy is a calculation for determining the accuracy of GPS points to an underlying road network. Values at the confidence level of 63% mean that 63% of the values are within a specified distance.

Table 1: HRMS 63% accuracy of public and forest road.

ROUTES	POSITIONAL ACCURACY STANDARD DEVIATION	MEAN	MAX	MIN	$(mean)^2 + (sd)^2$	HRMS (63%)
Truck 1 forest road < 100 m	21.28	17.11	100.00	0.03	745.47	27.30
Truck 1 forest road < 50 m	12.17	11.58	50.00	0.03	282.26	16.80
Truck 2 public road < 10 m	2.61	3.54	10.00	0.01	19.36	4.40
Truck 2 public road < 5 m	1.42	2.13	5.00	0.01	6.54	2.56
Truck 2 forest road < 100 m	28.00	29.95	100.00	0.28	1681.11	41.00
Truck 2 forest road < 50 m	13.79	17.64	50.00	0.28	501.12	22.39
Truck 2 public road < 10 m	2.80	3.75	10.00	0.01	21.94	4.68
Truck 2 public road < 5 m	1.40	2.05	5.00	0.01	6.15	2.48

to affect GPS performance and accuracy but for this project the authors are not attempting to define a correlation between density of forest canopy and GPS accuracy. The assumption of signal degradation is based on visual inspection within the forest.

For an articulated truck driving an average distance of 100,000 km/annum:

Average mileage from system = 7.5 mpg = 2.66 km/L

(1 mpg = 0.3540062 km/L)

7.5 mpg = 12.07 kmpg (2.66 * 4.54609)

100,000 km/12.07 kmpg = 8,285.00 gallons

==> 8,285.00 * 4.54609 = 37,664 litres

==> 37,664 litres * 0.8 €/litre = €30,131.20

==> CO_2 emissions = 37,664 L * 2.67 kg = 100,562.88 kg = 100.56 tonnes

For increase in fuel mileage to approximately 8.5 mpg (reduction in fuel consumption)

Average mileage from system = 8.5 mpg = 3.01 km/L

(1 mpg = 0.3540062 km/L)

8.5 mpg = 13.68 kmpg (kilometres per gallon)

(3.01 * 4.54609)

100,000 km/13.68 kmpg = 7,309.94 gallons

==> 7,309.94 * 4.54609 = 33,231.65 litres

==> 33,231.65 * 0.8 €/litre = €26,583.32

==> CO_2 emissions = 33,231.65 L * 2.67kg/L = 88,728.51 kg = 88.73 tonnes

==> Financial saving = €30.131.20 - €26,583.32 = €3,547.88

==> CO_2 emission saving = 100.56 T – 88.73 T = 11.73 tonnes

==> SAVING approximately €3,500/annum/truck on diesel fuel and 11.73 tonnes of CO_2 emissions simply by decreasing fuel consumption by 1 mpg due to increased driver performance.

ACTIVITIES PLANNED

This project is almost complete. Final activities include completing the final report, presentation of findings to FITG, publication of the papers and presentation of the research at Forest Engineering Group (FEG) on 10 March 2009.

Results of the study will be published in COFORD Connect notes and published on the COFORD website through the annual report. Similar reports will be circulated to members of the FITG (Forest Industry Transport Group).

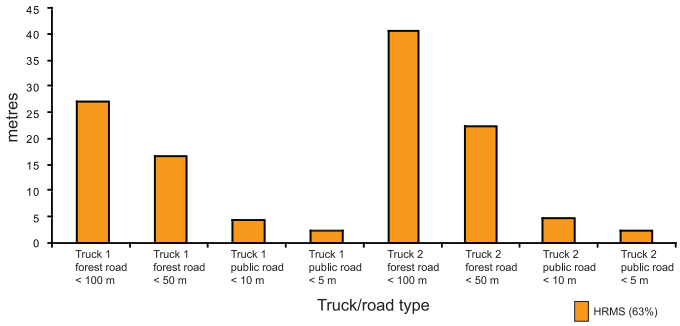

Figure 3: Graph of HRMS 63% accuracy for public and forest roads for trucks 1 and 2.

OUTPUTS

Presentation to the FITG meetings on 14 May and 16 October 2008 at Killeshin Hotel, Portlaoise, Co Laois.

Developing cost effective systems for wood procurement, harvesting and transport presented at the COFORD Technical Workshop on 22 February 2008, Killeshin Hotel, Portlaoise, Co Laois.

Presentation at the Agriculture Engineering Technology (AET) workshop in Brussels, on 31 October 2008

Devlin, G. J. and McDonnell, K. 2008. Performance accuracy of real-time GPS asset tracking systems for articulated trucks travelling on both internal forest road network and public road network. *International Journal of Forest Engineering* (in review).

Devlin, G. J. and McDonnell, K. 2008. Real time GPS asset tracking – Fuel for thought. *Journal of Transport Geography* (in review).