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Un GPS pour augmenter la précision

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GPS System To Boost Accuracy

A global positioning satellite (GPS) aided location synchronisation system has been developed which should improve even further the accuracy of track geometry measurement.

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MODERN technically-advanced track geometry measuring systems offer high accuracy and repeatability covering a wide array of track geometry and other track-related measurement parameters. This accuracy can be maintained at measuring speeds of more than 250km/h, enabling identification of even the smallest irregularities.

Yet, while it is important to maintain the accuracy and the repeatability of the geometry measurements, it is equally important to refer these measurements accurately to the correct location.

Traditionally, the location synchronisation of track geometry parameters has been achieved by having the operator of the track geometry car enter the exact location (in terms of the running distance from a predefined zero-point) and then press the synchronisation button at the correct time. However, it is very difficult, if not impossible, for the operator to enter the location and press the synchronisation button at the correct instant, especially at higher speeds.

With manual location synchronisation at speeds above 150km/h, repeatable location accuracies of only 5m can be accomplished. Since the manual location synchronisation is so inaccurate and error prone, devices such as magnets or so-called crocodiles are often employed. These devices are fixed to the track and their locations are known. When the car passes over such a device, an automatic trigger pulse is issued, eliminating the need for the operator to press the synchronisation button.

In most cases this approach works satisfactorily, but it does not guarantee full reliability of detection because the devices may be out of detection distance or may have been moved from their correct locations. Also, the operator still has the responsibility of entering the correct location and the associated header information for the generation of the exception reports.

A better approach to location synchronisation is the use of smart-coded automatic location detectors. Each one along the track stores either its unique identification number, which corresponds to an entry in a database containing the location and header information, or it contains the complete location and header information, which it sends to the host.

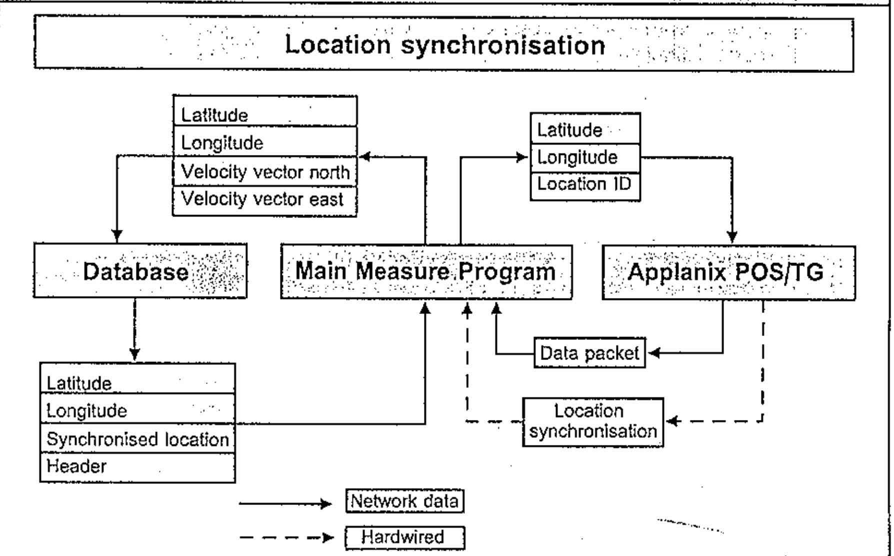
As the car drives by a coded automatic location detector, the location and header are automatically updated to the correct values. However, a disadvantage of this method is that it is costly to install the transponders across the rail network. Track maintenance machines can also easily damage or dislocate the detectors.

To overcome the disadvantages of these location synchronisation approaches, Plasser American Corporation and Applanix Corporation, Canada, have developed and deployed a GPS-aided location synchronisation (GALS) process.

GALS' functionality is implemented in the Applanix position and orientation system for track geometry (POS/TG) measuring system.

The GALS approach is to first store the geographic locations (latitude and longitude) of the points of interest—the synchronisation points—in a database. Then, during a measurement run, GALS continuously minimises the distance between the current

DATA FLOW IN GALS PROCESSING



THE data flow in GPS aided location synchronisation (GALS) processing in the illustration above is as follows:

Applanix POS/TG continuously sends the current position of the geometry car (latitude and longitude) and the velocity vector (north and east components) to the Main Measure Program.
Once every 100m of the distance travelled, the Main Measure Program sends these data to the Database Processing Program.
The Database Processing Program searches the facility database, extracts all the location synchronisation entries that are in a half circle of a predefined radius ahead of the car, and sends them to the Main Measure Program.
The Main Measure Program attaches unique identification numbers to the location synchronisation entries and passes them to Applanix POS/TG.
Applanix POS/TG verifies the location synchronisation data and discards invalid sets.
When POS/TG establishes that the car is approaching the synchronisation location and that it is in close proximity to the synchronisation location, it sends the corresponding location ID back to the Main Measure Program.
When the car reaches the synchronisation location, a synchronisation message and a synchronisation pulse are generated by the Applanix POS/TG system.
The Main Measure Program resets the location and the header information to the entry corresponding to the location ID.

location of the car and the appropriate synchronisation locations. Once the minimum is reached, GALS issues a synchronisation message and a synchronisation signal. The process is fully automatic and reliable.

Using the integrated inertial navigation algorithm, the Applanix POS/TG computes the current location of the car. Integrated inertial navigation optimally blends the inertial data with the data from the aiding sensors, such as the GPS receiver.

Worldwide Coverage

GPS is a service that was originally developed for the US military and is now available to the public. With its 24 satellites orbiting the Earth, GPS provides users with worldwide coverage and position accuracy to within a few metres. If a better position accuracy is required, as is the case for the location synchronisation, differential GPS is used. Differential GPS' accuracy to within a few decimeters or better can be achieved in real time operation.

There are several advantages of using the blended GPS-inertial position from POS/TG compared with using the position from the GPS receiver. First and most important is data integrity. GPS position may not always be available due to outages typically caused by the obstruction of the line of sight between the GPS antenna and the satellites.

This often happens when bridges, tunnels and other infrastructure prevents the satellite signals from reaching the GPS antenna. Unlike the GPS, POS/TG position is available continuously, as the inertial component of integrated inertial navigation provides the position data even when the GPS signal is unavailable (with some degradation of accuracy during long outages).

The second advantage is the bandwidth of the position output. Most GPS receivers provide position samples every second. For example, if the car speed is 80km/h (or approximately 22m/second), then GPS provides a position sample every 22m. POS/TG computes its navigation data 200 times/second. At 80km/h, the car's position is thus sampled every 110cm. The third advantage is the attenuation of the noise, as blending of GPS data with inertial data causes the GPS position noise to be smoothed out.

Compared with the other methods, we believe that GALS processing is the most advanced and reliable location synchronisation method currently available. It combines all the advantages and eliminates all the disadvantages of other existing synchronisation methods. The hardware required for GALS processing comprises the Plasser computer system, the Applanix POS/TG track geometry measuring system (with embedded GPS receiver), and a differential GPS receiver. It is not necessary to install any hardware devices on the railway.

Reference (synchronisation) locations can be determined from track surveying using POS/TG (with enhanced accuracy, if needed, provided by post-processing of recorded data). The procedure is automatic and accurate, and eliminates the need for manual surveying. Alternatively, the synchronisation points can be derived from a geographical information system (GIS), if available.

The standard Plasser American Corporation facility database incorporates synchronisation points in addition to wayside events and header information for the entire rail network. This draws an association between each synchronisation point and the corresponding header, and it enables extraction of the header information when the car passes a synchronisation point.

GALS is currently employed by Austrian Federal Railways (ÖBB), which has been using the system since the beginning of the year. This operation on a daily basis has proved that GALS is a valuable tool for maintaining location and header information, and dependably referencing the geometry data and track related measurement parameters to their locations of validity. **IRJ**