Local Area Positioning of Multiple Moving Objects

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"It doesn't prove anything much except that the awesome splendour of the universe is much easier to deal with if you think of it as a series of small chunks."

"Mort" Terry Pratchett, 1987

Abstract

This research examines a number of aspects of position tracking in complex environments. It postulates that configuring the receivers of the system in a regular fashion does not give optimum results when obstructions are present (especially moving obstructions). The tracking of rugby players is used as a primary example of position tracking in a complex environment. Other applications are considered.

The current literature in the field of position tracking and synchronisation was examined to find the state of the art. This suggests that the method best suited to the research goals is a time-based positioning method using unsynchronised transmitters attached to the players coupled with time-synchronised receivers.

Specifications were generated that defined the minimum operating requirements for a position tracking system that is suitable for use in a sporting application. These specifications are used to create and assess a minimalist tracking system.

A suitable system is characterised and the results are used to derive a model predicting the visibility of a player to the tracking system. For given player positions, and system components, the model determines the visibility of the players. It is designed to be fully configurable to handle any position tracking system and operating environment. The model is used as part of an expert system for performance assessment.

Configuration of the receivers is an important optimisation parameter for the tracking system's performance. A genetic-algorithm optimisation process was tested with several objective functions to find the optimal placement of receivers in both open-field and static-obstruction situations. Calculated optimum solutions are shown to be superior to solutions-by-inspection. Furthermore, the optimisations confirm the premise regarding regular receiver configurations.

Test results show that some loss of visibility is inevitable in a minimalist system and that missing data can be recovered by software, thus increasing system performance while maintaining minimal equipment. A reconstruction algorithm was developed to handle missing data. The known behaviour of objects (specifically rugby players) was characterised into a series of rules to reconstruct missing data from data nearby in both time and space.

Finally, a simulation was performed using game data provided by the Industrial Partner and bringing together the various, disparate threads of research. The system as a whole achieved 93-99.5% player visibility with the use of optimum receiver placements and application of the reconstruction algorithm.

It is concluded that eight is the optimum number of receivers to satisfy the specifications of a minimalist system and that the expert system was successful.

The knowledge created by this research can be applied to any tracking system in order to maximise its efficiency in a given environment. It also demonstrates that the required volume of equipment can be reduced through the use of software tools.

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