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Biologically inspired model of path integration based on head direction cells and grid cells

Key words: Head direction cells (HDCs), Grid cells (GCs), Path integration, Bionic navigation

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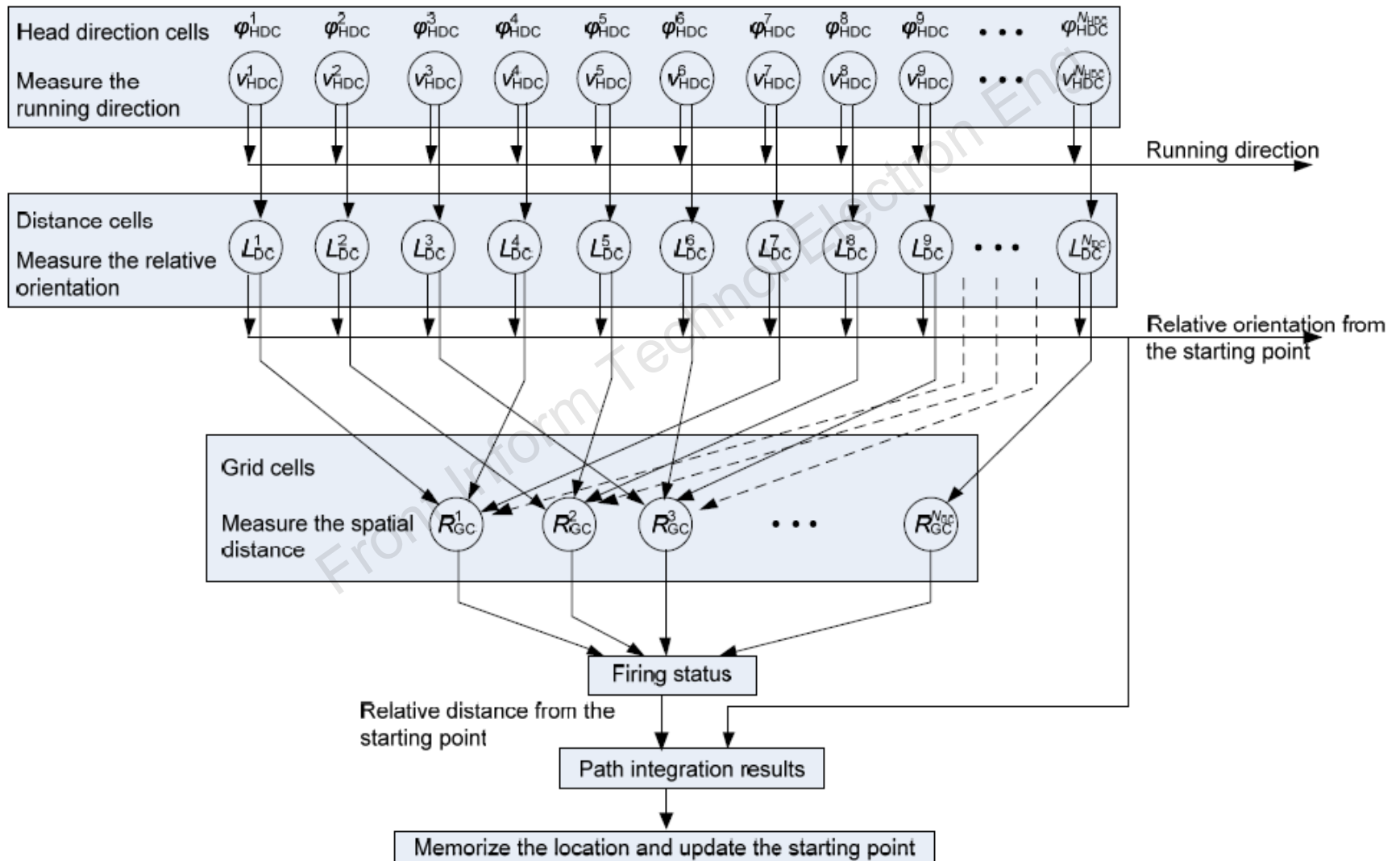
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Introduction

- With the development of biology, neuroscientists have found that head direction cells (HDCs) and grid cells (GCs) are related to the running direction and distance.
- To provide a bionic approach for the vehicle to achieve path integration, we present a biologically inspired model of path integration based on the firing characteristics of HDCs and GCs.
- In the proposed model, the navigation physics parameters are effectively associated with the firing of cells, which can finally provide path integration information for the vehicle through a bionic approach.

Process of the path integration



Path integration results (1)

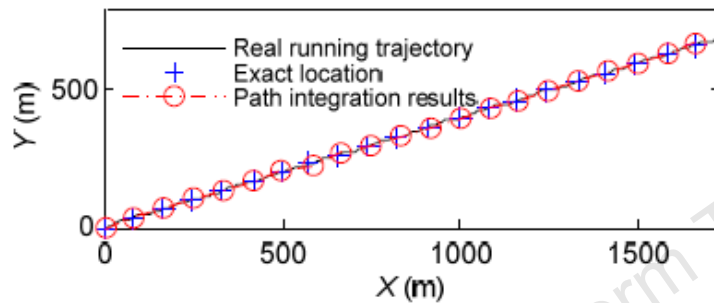


Fig. 12 Real running trajectory and path integration results for beeline running

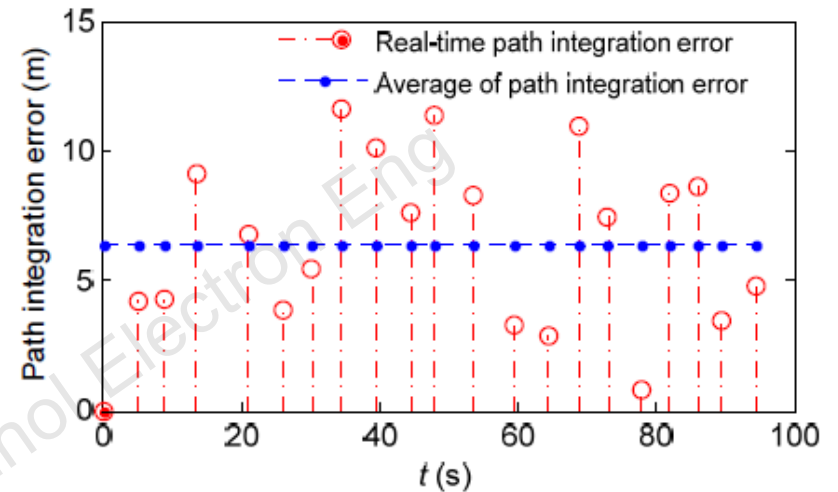


Fig. 13 Path integration error during beeline running

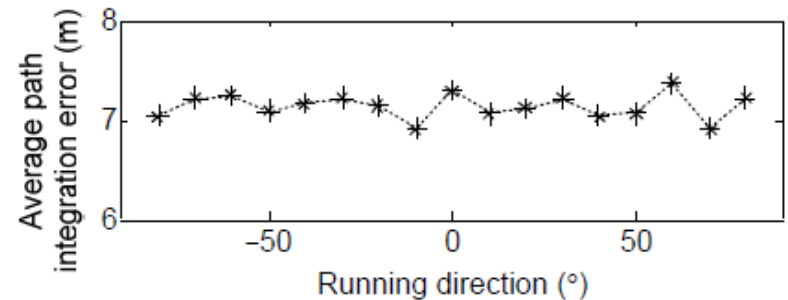


Fig. 14 Average path integration error of beeline running in different directions

Path integration results (2)

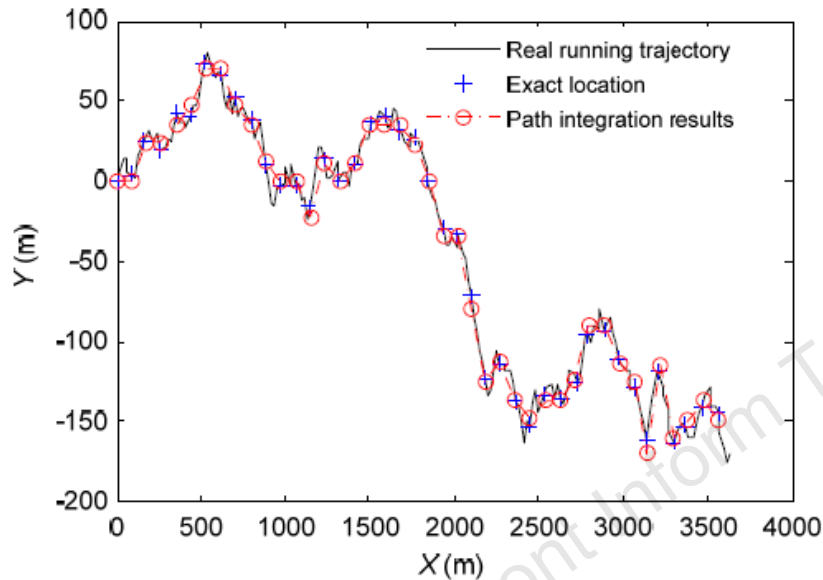


Fig. 17 Real running trajectory and path integration results during curve running

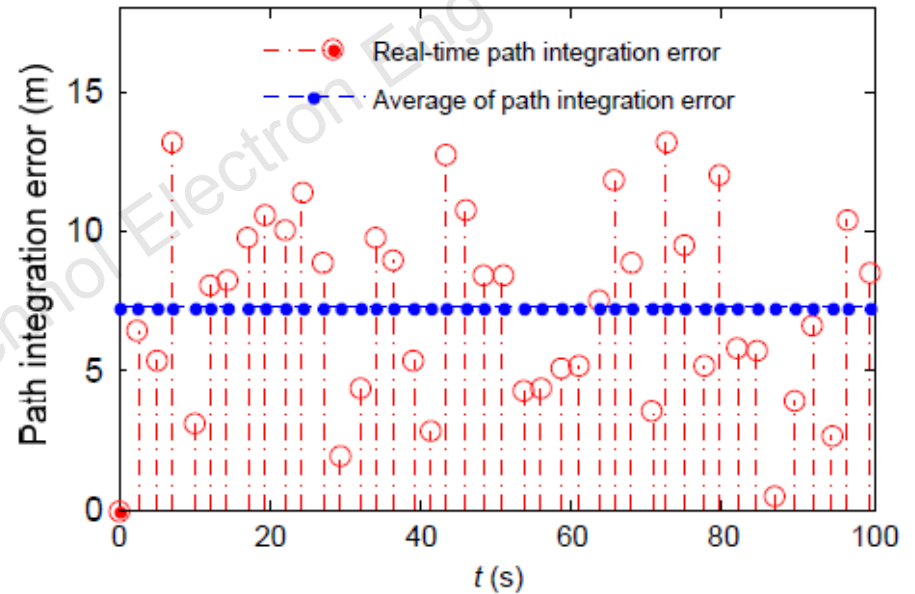


Fig. 18 Path integration error during curve running

Path integration results (3)

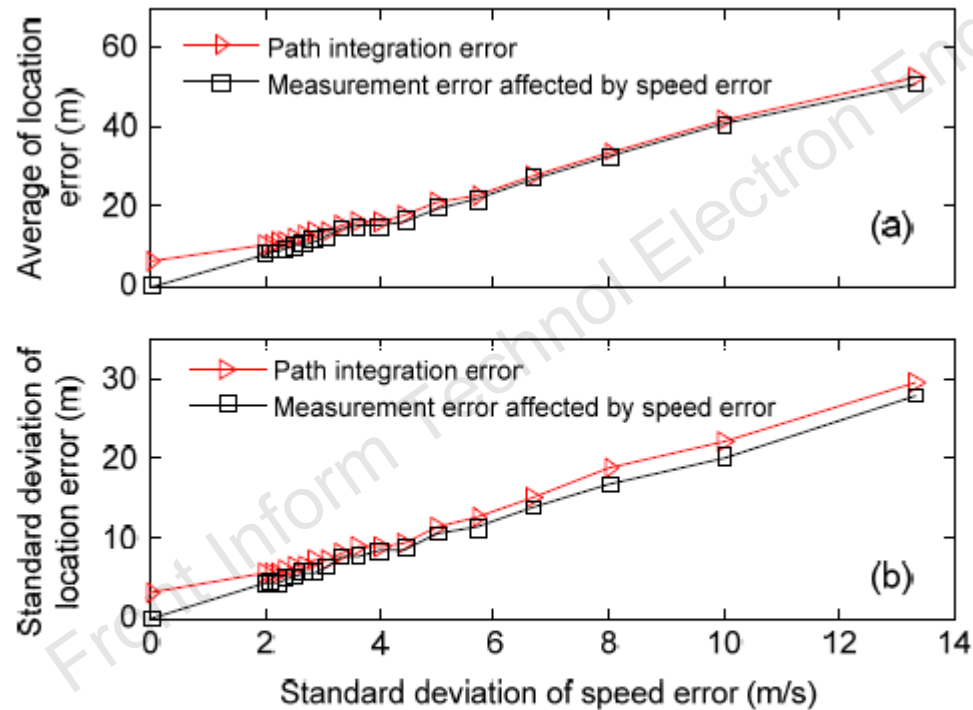


Fig. 23 Path integration results at different speed errors:
(a) average location error; (b) standard deviation of the location error

Conclusions

- The proposed path integration model is proved to be realizable, and the navigation physics parameters can be obtained by perceiving the firing of HDCs and GCs, which shows the validity of the relation between the navigation physics parameters and the firing of cells.
- The model parameters, such as the number of HDCs, grid spacing and firing field radius, influence the path integration performance, and the setting conditions of grid spacing and firing field radius provided in the Section 2.3.2 are effective.