PhD position

LISITE- ECoS ISEP

Field:

Chemistry for nanos	☐	Molecular electronics	☐	Process Technologies	☐
Imaging devices & Systems	☐	Nanocharacterization	☐	RF Devices & Systems	☒
Materials	☐	Nanoelectronics	☐	Spintronics	☐
Memory technologies	☐	Nanos for Energy	☐	Other	☒
MEMS and sensors	☐	Nanoscale simulation	☐	Algorithm & compiler	☒
Microtechnologies for bio	☐	Photonics	☐	Computing architecture	☒

Required	Duration	Start		
Master	36 months	From Sept. 2023		

Topic: Brain-Inspired Localization Model based on Visible Light Communication for Indoor Navigation

Context:

ISEP has an open PhD position for a project on visible light technologies for simultaneous communications and illumination. The project aims at studying a brain-inspired positioning and navigation technology for indoor visible light-based location application. Indoor navigation is a challenging task, and it requires a reliable and accurate localization system. Traditional localization systems rely on GPS or Wi-Fi signals, but these systems may not be suitable for indoor environments due to poor signal penetration and signal strength. Therefore, there is a need to develop an efficient and robust localization system for indoor navigation.

Brain-Inspired Positioning and Navigation is a new and promising way to achieve a more robust, energy-efficiency, and generalized positioning and navigation solution for real-word applications, especially for future industry Digital Twins scenario. The Nobel Prize-winning research on navigation-related cells in the rodent brain has provided insights into the principles of spatial navigation. Grid cells[1], in particular, show topological properties in the process of activation discharge[2,3], which has similarities with the topological maps used in pigeon navigation[4,5,6]. Therefore, it is possible to develop a brain-inspired localization model for indoor navigation based on the principles of grid cells. The overall framework of the brain-inspired navigation model based on absolute heading is shown in Figure.1. Inspired by this neural mechanism of the internal GPS in the brain, brain-inspired positioning and navigation methods aim to not only improve the accuracy but also enhance the robustness, energy efficiency. and generalization ability of the system by continuously learning.

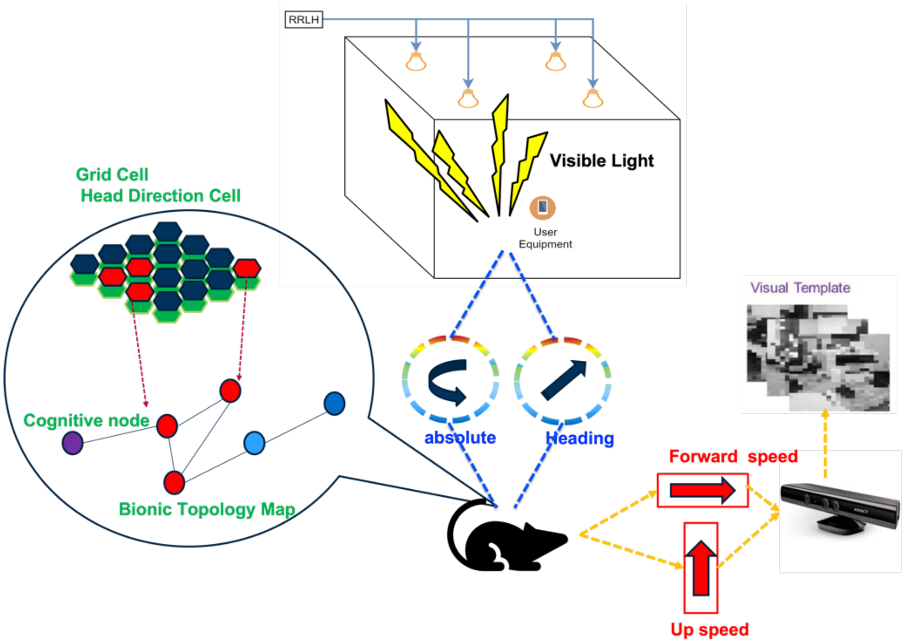

Figure 1. Schematic of brain-inspired navigation model based on absolute heading.

Meanwhile, Visible light technologies are emerging as promising candidate for providing simultaneously illumination and communications. Interest in visible light communication (VLC) is driven by the advances in light emitting diodes (LED) technologies and the need to find new spectrum resources for wireless communications. Advantageous features like geographical independent usage and cost effectiveness makes VLC and ideal candidate for simultaneous illumination and communications.

The proposed project involves the modeling of navigational cells (e.g, place cells, grid cells, heading cells) and algorithm of brain-inspired positioning, navigation, and mapping in using of visible light communication (VLC) for indoor localization.

The brain-inspired localization model is based on the principles of grid cells. The model consists of a grid cell layer that generates a spatial map of the indoor environment. The spatial map is updated based on the received light signals. The model also includes head direction cells that provide information about the orientation of the receiver in the indoor environment. The model uses a combination of place cells, boundary cells, and speed cells to estimate the position of the receiver accurately.

It aims to develop a brain-inspired localization model based on visible light communication for indoor navigation. The approach is inspired by the principles of grid cells, which show topological properties in the process of activation discharge. The proposed approach has the potential to provide an accurate, robust, and scalable localization system for indoor navigation.

Meanwhile, based on the experience of European project H2020 IoRL and 6G BRAINS [7,8], Visible light technologies are emerging as promising candidate for providing simultaneously illumination and communications. Interest in visible light communication (VLC) is driven by the advances in light emitting diodes (LED) technologies and the need to find new spectrum resources for wireless communications. Advantageous features like geographical independent usage and cost effectiveness makes VLC and ideal candidate for simultaneous illumination and communications.

The proposed approach will be evaluated in a real indoor environment in ISEP. The evaluation will focus on the accuracy, robustness, and scalability of the localization system. The accuracy of the system will be evaluated by comparing the estimated position of the receiver with the ground truth position. The robustness of the system will be evaluated by testing the system under different lighting conditions and interference sources. The scalability of the system will be evaluated by testing the system in large indoor environments.

Keywords: Brain-insipire, *VLC, Indoor positioning*, *Indoor navigation, Data fusion*

Required skills:

- Telecommunication: wireless communication, MIMO, OFDM, Digital communication
- Knowledge on Deep learning, Machine learning algorithm
- Collaboration between design team and compiler team

Appreciated skills:

- Knowledge in AI algorithm (digital and/or full custom)
- Knowledge in wireless communication
- Writing skills for academic publications

PhD position

LISITE- ECoS ISEP

Lab

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References:

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[7] Horizon 2020 IoRL projet : https://iorl.5g-ppp.eu/
[8] Horizon 2020 6G BRAINS projet https://6Gbrains.5g-ppp.eu/