PhD Thesis proposal

General Information		
PhD Thesis Title	**Shape formation and AI decision making for Nano Modular Robots**	
Doctoral Degree	PhD in Computer Science University of Franche-comté, Belfort, France	
Research Unit	NA	
Laboratory	NA	
Axis	Robotics, Distributed Systems, Graph Theory	
PhD Supervisors	Name & Title: Dr. Bachir Habib Email: bachirhabib@usek.edu.lb	University Address: Holy Spirit University of Kaslik-USEK
Co-supervisors	Name & Title : Dr. Abdallah Makhoul Email: abdallah.makhoul@univ-fcomte.fr	University Address: University of Franche-comté, Belfort, France
Locations	Location 1: USEK	Work shift calendar /per year (%): 75%
	Location 2: UBS	Work shift calendar /per year (%): 25%
Potential funding and scholarship	CNRS	

Applicant Profile and/or Special Requirements	MS in Computer Science or equivalent

Subject's national or worldwide Context, Objectives & Research lines
One of the recent research subjects in the world nowadays is Nano Modular Robots. These are programmable matters that can change their physical shape autonomously to complete a specific task. The potential of such technology is tremendous. These systems present huge challenges for researchers. This kind of robots have no central control, limited memory and processing power, and no random function can be used due to their homogeneous structure. Three phases must be considered: First, the nano robots must elect a leader. Second, a security protocol must be established in order to secure the system. Third, a shape formation must be done in order to perform a required task. In this context, we propose a research subject to create a decision-making algorithm (AI based) that covers all possible scenarios in the environment and to propose a shape formation and a plan for the leader to act. Then, a new 3D shape formation algorithm must be developed. Finally, all the phases must be implemented on VisibleSim and on hardware developed by our lab in France.

Outcomes (OCs) : What do we wish to achieve?	
OC1:	Design of decision-making algorithm for the leader in nano-modular robots

OC2:	Developing of new 3D shape formation algorithm for nano modular robots.
OC3 :	Implementation and test of the complete phases on VisibleSim and on hardware.

References (R) (5 most recent peer-reviewed publications)	
R1:	“Distributed Self-Reconfiguration using a Deterministic Autonomous Scaffolding Structure”, Pierre Thalamy, Benoît Piranda, Julien Bourgeois, Proceedings of the 18th International Conference on Autonomous Agents and MultiAgent Systems, 2019.
R2:	“Static local coordination avoidance for distributed objects”, Tim Soethout, Tijs Van Der Storm, Jurgen J. Vinju, Proceedings of the 9th ACM SIGPLAN International Workshop on Programming Based on Actors, Agents, and Decentralized Control, 2019.
R3 :	“A Distributed Self-Assembly Planning Algorithm for Modular Robots”, Thadeu Tucci, Benoît Piranda, Julien Bourgeois, Proceedings of the 17th International Conference on Autonomous Agents and MultiAgent Systems, 2018.
R4 :	“Brief Announcement: A Local Stochastic Algorithm for Separation in Heterogeneous Self-Organizing Particle Systems”, Sarah M Cannon, Joshua J Daymude, Cem Gokmen, Dana Jill Randall, Andréa W. Richa, Proceedings of the 2018 ACM Symposium on Principles of Distributed Computing, 2018.
R5 :	“A Distributed Self-Reconfiguration Algorithm for Cylindrical Lattice-Based Modular Robots”, André Naz, Benoît Piranda, Seth Copen Goldstein, Julien Bourgeois, The 15th IEEE International Symposium on Network Computing and Applications, At Cambridge, MA, USA, 2016.