PHD PROPOSAL

- **Title:** Optimal Camera Placement for Urban Parades and Demonstration Marches Monitoring
- **Supervisors:** L. Idoumghar, J. Lepagnot & M. Brévilliers
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- **Location:** University of Haute Alsace, Mulhouse, France
- **Duration:** 36 months

Context:

This PhD position is part of a joint French–German research project on future security in urban areas, funded by the French National Research Agency (ANR) and the German Federal Ministry of Education and Research (BMBF), from 2017 to 2020. This project is entitled "Organized Pedestrian Movement in Public Spaces: Preparation and Crisis Management of Urban Parades and Demonstration Marches with High Conflict Potential" (OPMoPS). The main outcome of this project will be a decision support tool based on mathematical, computer science and sociological research, which will help the forces of civil security (FCS) to prepare and control urban parades and demonstration marches (UPM), to detect risk situations, and to react to possible threats to individuals and civil security fast and efficiently.

In this context, the LMIA laboratory coordinates the work of the French involved partners and leads an optimization work package devoted to solve the following research problems: find good locations for security personnel before and during the UPM, roster plans for security personnel, evaluate suggested and recommend good UPM routes, placement of cameras and drones with automatic detection of main hazardous situations.

In this work package, the proposed PhD position will focus on the optimization of camera and drone placement in the monitored public area.

Description:

Public area monitoring with drones and cameras is of particular value in case of UPM. Such a system can help the FCS as an intelligence service. For example, it can be used to detect and locate faster agitation behaviors in the crowd or rioters in order to react in a suitable way as soon as possible. This research subject can be divided into three main parts. First, it should be planned where the drones and cameras have to be placed to offer the best quality of service, for example in terms of coverage of the monitored area, or in terms of total cost for the authorities. In the literature [1], the problem is often handled as the coverage of a 2D surface (the ground), and the coverage of a 3D space has not been deeply investigated until now [2]. However, this constraint seems to be important because blind spots cannot be allowed (at least in some critical areas) to ensure a good quality of service. Another notable challenge is that the methods currently available are not scalable to large surveillance areas.

The aim of PhD thesis is to provide optimization algorithms (metaheuristic-based) that can propose satisfactory solutions for the placement of cameras and drones in the monitored area. Depending on the size and the complexity of the problem, dynamic optimization techniques can be used. Dynamic optimization algorithms are dedicated to solve problems that changes over the time. They intend to be significantly more efficient than static optimization algorithms for this kind of problems. By formulating the problem at hand as a dynamic optimization problem, the proposed algorithms can be scalable to larger surveillance areas, and intrinsically suited to take into account any change in the monitored area in order to quickly provide a new optimal solution for the placement of the drones. Furthermore, parallel methods (like distributed computations, or GPGPU) can be implemented to ensure a reasonable runtime execution.

The optimization group of the LMIA laboratory has initiated research work on this problem in 2016, as part of an institutional project funded by the University of Haute-Alsace, entitled "optimal camera placement for automatic detection of hazardous situations". The proposed algorithms have already been partially parallelized on GPU, and they produce encouraging results for basic test problems. The work done in this local project seems to be a good starting point for a deeper study concerning security in urban areas, as a part of the OPMoPS project.

References:

[1] Yi-Ge Fu, Jie Zhou and Lei Deng. Surveillance of a 2D Plane Area with 3D Deployed Cameras. Sensors, Vol. 14:2, 2014.

[2] Maher Rebai, Matthieu le Berre, Faicel Hnaien and Hichem Snoussi. Exact Biobjective Optimization Methods for Camera Coverage Problem in Three-Dimensional Areas. IEEE Sensors Journal, Volume 16, Issue 9, 2016.

Work plan:

For this PhD thesis, the following phases should be followed:

1. Write a state of the art on this class of problems and the related methods used to solve them ;
2. Efficient solving of the problem using fixed cameras and stationary drones ;
3. Extension of the problem to optimal patrol planning for drones ;
4. Real-time planning update to take into account what happens during the UPM.

Prerequisites:

- The candidate must have a Master or equivalent in computer science or applied mathematics. The candidate must have good knowledges in metaheuristics, GPU and/or MPI programming.
- Programming language: C++.
- Good knowledge of development under Linux.
- The candidate must be fluent in English.

Application:

Send by email a CV, a cover letter, the report cards containing all your marks obtained during your Master studies, 1-2 recommendation letters.