Related work on SAR with multi-robot systems, integrated coverage and connectivity problem (can also be from sensor networks)

In the study in \cite{lamine2019coverage}, area coverage of a drone fleet is optimized with connectivity as one of the constraints of a SOO formulated as an integer linear programming model using the solver CPLEX. Results indicate that the mission time reaches 1 hour as the map size increases. In time-sensitive cases this is very bad performance. In \cite{rosalie2017coverage}, authors have proposed the CACOC2 algorithm to optimize connectivity alongside coverage, improving on the CACOC algorithm employing a push - pull topology, i.e. if connectivity goes down a certain threshold UAVs replan their paths to improve connectivity while decreasing coverage performance and vice versa. Drones make a decision on next orientation (left, right, straight) based on “pheromones”. In \cite{messous2016network}, there is also the energy consumption performance criteria besides coverage and connectivity that one has to take into consideration when designing a UAV system. As the UAVs cannot charge on the go, it is imperative that we conserve as much energy as possible. This paper incorporates that aspect into the UAV system. In this study, there is no initial path plan and the decisions made by each drone is made locally with a high reliance on neighbor data and drones can be disconnected in order to cover a large area. In \cite{adam2020connectivity}, two novel path planning algorithms have been proposed, one being connectivity based and the other being coverage based while the authors focus on optimizing resource allocation depending on the mission demands. In \cite{hayat2017multi}, A genetic algorithm is used to solve a MOOP, coverage and connectivity are assumed to be the objectives to be optimized by minimizing the mission time. The algorithm can be modified to prioritized coverage or connectivity. The algorithm considered three approaches: inform-first (IF), connect-first (CF), and simultaneous inform and connect (SIC) for connectivity to optimize the coverage paths. In \cite{hayat2020multi}, Two adaptive methods based on SIC strategy are proposed to solve a multi-objective path planning (MOPP) ; The first one optimizes search, inform, and monitor tasks simultaneously, and the second one first optimizes search and inform tasks together and then finds the optimum positions for monitoring. Finding the shortest path is the objective of the UAV MOPP subject to connectivity constraints. In \cite{8886129}, the graph search technique proposes a low-complexity path planning algorithm concerning connectivity and the objective is finding the shortest path subject to connectivity constraints. In \cite{abdel2017optimum}, connectivity and coverage are considered as objectives that should be optimized simultaneously. The result is optimizing the UAV's position. A single UAV have been employed and supposes a small-cells (SCs) network containing M SCs and N user equipment (UEs) with severe path loss without connectivity to any SC. The SC's connectivity is modeled as a weighted simple finite graph. The Signal-to-noise ratio (SNR) reflects the coverage for UEs. The problem is first formulated as a non-convex problem and converted to a standard convex SDP problem for UAV positioning. In \cite{danoy2015connectivity}, connectivity is maximized by utilizing a bi-level flying ad-hoc network (FANET) where the upper level of UAVs form a “bridge” to the BS while the lower level of UAVs are responsible for the SaR. This is a good solution but requires an abundance of UAVs so it is highly resource intensive and if one level goes down (i.e. the “bridge” gets disconnected), then the mission fails as one level of UAVs cannot do the other level’s job because the main aim of this study is to implement a less complicated bi-level multi - UAV system (i.e. each level is programmed and designed to perform a specific task).