Blog Post 3 of: Racing the Clock: Energy-Aware Path Planning for Efficient Drone Missions

One of the biggest constraints for any UAV mission is battery life. In a large-scale disaster like a wildfire, you need to cover a massive area as quickly as possible. This is why our team developed a specialized **Energy Aware Coverage Path Planning (mCPP)** approach.

The core objective is simple: **plan paths for multiple UAVs that minimize the number of flights needed, while ensuring the energy required for any single path stays below a user-defined limit**.

Here's how we do it:

1. Slice the Area (Intelligently) First, we take the complex Area of Interest (AOI) and rotate it to find the best angle for coverage. Then, we use a technique called **Boustrophedon Cellular Decomposition (BCD)**. This is a fancy term for slicing the complex polygon into a set of simpler, non-overlapping sub-polygons. If we don't have enough "slices" for our drones, the algorithm automatically divides the largest polygons further.

2. Generate Path Options For each simple sub-polygon, the algorithm generates several different "back-and-forth" (sweeping) coverage paths. Crucially, it estimates the *exact* energy consumption for each of these potential paths. This estimation is based on the UAV's physical parameters and the optimal speed to maximize flight distance.

3. Solve the "Traveling Salesman" Puzzle Now we have dozens of path options for all these different sub-polygons. We convert this into a **Multiple Set Traveling Salesman Problem (MS-TSP)**. This is like a complex puzzle where the goal is to find the cheapest "tour" for our team of drones to "visit" a set of these pre-planned paths, covering the entire area with the *least amount of total energy*.

To solve this complex problem quickly, we use a meta-heuristic algorithm called **Greedy Randomized Adaptive Search Procedure (GRASP)** combined with **Tabu Search (TS)** to find a high-quality (even if not perfectly optimal) solution in a short time.

The result, shown in Figure 5, is a set of efficient, energy-aware paths that allow a swarm of 5 or 8 UAVs to effectively cover the same large, complex area.

Next post: What about disaster zones that are even more complex, with "holes" and "no-fly zones"? We'll cover our optimized method for handling exactly that.