Autonomous Surface Vehicles - Swarm Optimisation

Background:-

Autonomous marine vehicles are remarkably useful for tasks such as shallow water surveying, environmental data collecting and military operations such as surveillance and weapon delivery. Because of the necessity for autonomous marine vehicles and the challenges they impose, they have gained a widespread interest among the researchers around the world. This is one of the main reason that motivated us to do our contribution in solving many challenges of Autonomous Swarm Surface Vehicles. I mainly focused on developing a small prototypes of Autonomous vehicle and Optimisation.

Approach/Proposed Solution:-

The mechanical structure of the surface water vehicle is designed to be small and lightweight, to offer both robustness and greater flexibility while floating in water. It should be easy to carry and easy to adjust to the dynamics of the ocean surface. The ASV is equipped with a microcontroller, sensors, motors and Wifi Module. Each ASV can be equipped with several sensors - GPS, IMU, temperature sensor, etc. In the basic prototype, we used only GPS sensor. The processor has direct control over sensors and camera. A set of rechargeable batteries within the motor base provides autonomy for about three hours. Notably, a catamaran model has been developed. Further, in order to establish communication between multiple ASVs, a WiFi module is made available in each ASV. In the absence of significant interference, this WiFi module would assist in establishing connection between the ASVs even if they are 300-400m apart from each other. The master will be the server and file transfer [of GPS data] will be done through server-client communication within the same network.

In Real time, 300-400m is not a considerable distance for two ASV. So using some meta-heuristics, Optimised Swarm network will be established.

Novelty:- Though many researchers have worked in designing and developing an Algorithms for optimisation, there isn't much progress in development side. As a part of this project, i implemented the algorithms[PSO and ANT Colony Optimisation] for optimisation

Results:-

1. We developed a boat [catamaran model] and tested in the canal nearby. It is floating properly in the water and moving autonomously. We can also control with our PC. It also sends the GPS coordinates.
2. We implemented two optimisation Algorithms.

a. Particle Swarm Optimisation
b. ANT Colony Optimisation

A small simulation has been made in MATLAB to visualise the results. Python version of these algorithms has also been made. So that it will be easy for the persons who continues their work on this project because python codes can easily run in Raspberry pi.

Tech-Stack:-

Languages:- Bash, Python, Matlab
Software:- Raspbian OS, MATLAB, OpenCV
Hardware:- Raspberry PI, WebCam, Motors, GPS Module [I mentioned only main Components].

Challenges:-

In developing Hardware, we didn't face many challenges, But the only challenge was speed. The vehicle is moving quite slowly. In optimisation part, i didn't have enough resources available in the internet. So algorithms made me spent sleepless nights to implement them.