Requirements

In order to improve the design process, a number of requirements are made. These are divided into three parts. First there are the requirements of the problem itself, secondly are the requirements for our solution and lastly are the requirements for the simulation we wish to create.

Requirements problem

1. The system needs to be able to find driftwood in a predetermined environment.
    a. The system needs to be able to push driftwood to a location where this can easily be collected and removed. This should also be a location where the driftwood is not an obstacle for other business in the harbour (the hub).
    b. The system needs to be able to find wood in sizes ranging from 20 cm to pallet size and different shapes (planks, branches or blocks and logs).
    c. The system has to determine the shape and size, and then make a decision on how to handle the pieces of driftwood.
2. The system needs to check the water for pollutions of an unknown source.
    a. The system needs to compare the information from its sensors (pH, EC, DO and UV) to the allowed values. These allowed values are described in the permit of the company. This says how much from which substance a company can legally ad to the water it releases into the environment.
    b. The system needs to be able to find the maximum of a pollution, the location where the concentration is the highest.
    c. The system needs has to make a map of the pollution. If the system finds a pollution it has to find the total size and location of the pollution.
    d. The system needs to take a picture of the maximum in order to gather proof for police and other agencies.
3. The system needs to be able to check whether ships are illegally dumping into the water, creating pollutions.
    a. The system needs to compare the information from its sensors (pH, EC, DO and UV) to the allowed values.
    b. The system needs to be able to follow ships from a safe distance.
    c. The system needs has to make a map of the pollution. If the system finds a pollution it has to find the total size and location of the pollution.
    d. The system needs to find the maximum of a pollution, or determine whether a ship is leaking.
    e. The system needs to take a picture of the maximum in order to gather proof for police and other agencies.

Requirements solution

These are the requirements we have made for our solution to the problem, namely using swarm-robotics.

4. There are a few demands for the system of the swarm.
    a. The swarm needs to work with minimal human input. The environment needs to the given. The threshold values for the sensors (pH, EC, DO and UV) have to be given. After this the swarm can be activated and will work on its own.
    b. The swarm needs to be able to operate 24 hours a day, 7 days a week.
5. The swarm needs to be able to interact with its environment.
    a. The swarm cannot obstruct other traffic or work on the water and harbour.

b. The swarm needs to move through the environment with collisions or unnecessary movements, like continuously moving in circles.
c. The swarm needs to resist effects of the environment. Up to wind force 7 the following demands stand:
    i. The individual drones cannot be flipped over by waves.
    ii. The individual drones are not allowed to be carried away by wind or water flows too far. A drone is too far away when it is out of communication range of the rest of the swarm.

6. Demands for the hardware of the swarm.
    a. The drones need to able to get a top speed of 13 km/h.
        i. This speed needs to be obtainable independently of wind speed and direction or flow speed and directions.
        ii. The drones need enough power to move driftwood, if needed with the help of other drones. To determine the threshold for when a drone has call in help to move a piece of driftwood, a prototype has to be made and tested for its power.
    b. The drones need to be tough enough to have no damage in collisions up to 10 km/h.
    c. An individual drone has to be able of being activated at least 6 hours before needing to get to a charging station (the hub).
        i. The individual drones need to the able to get charged at a charging station (the hub).
        ii. The drones need to be able to charged using solar panels.
    d. The individual drones need to be able to float on the water.
        i. The drones need to be waterproof up to a pressure of 20 bar.
    e. The individual drones need to following hardware for its measurements.
        i. Cameras for recognizing objects and the environment. These are also used for taking pictures. Objects need to be recognizable up to 500 meter.
        ii. A stream sensor for measuring flow speeds and directions.
        iii. A pH-sensor to measure the pH-value of the water, ranging from values of 5 to 11 moll/l.
        iv. A DO-sensor to measure the amount of oxygen in the water. The range fort his sensor has to between 8 to 15 mg/l.
        v. An EC-meter to check the concentration of salts in the water.
        vi. A UV-fluorescence meter to check for oils on the water.
        vii. A GPS to check the location of the drones, with an accuracy of up to 5 meters.
    f. The drones need equipment for their communication.
        i. The range of the communication needs to be big enough for the system and environment, for this we hold a range of 500 meters.
        ii. Individual drones need to be able to communicate with another.
        iii. The swarm needs to be able to communicate with a higher network to rapport its results.

7. The system needs to be redundant. Functions cannot (completely) disappear because of damage to individual drones.
    a. The swarm needs to recognized damaged drones.
    b. Drones have to be able to take over for drones that can no longer function.
    c. The swarm needs to be able to return broken drones to the hub. If a broken drone cannot return on its own, it will get help from other drones.

8. A few demands for the software of the individual drones and the complete swarm:
    a. Individual drones need to communicate with the rest of the swarm.
    b. The warm needs to be able to rapport its findings to a higher system.
    c. The swarm needs to be able to make decisions about its behaviour.
        i. The swarm needs to be able to make priorities between different tasks.
        ii. The swarm needs to be able to divide itself over different tasks.
    d. The individual drones need to make measurements to check the water quality using its sensors (requirements 6.e).

Requirements Simulation

Finally there are some requirements for the simulation.

9. The simulation time has the following demands:
    a. The total time simulated needs to be able to be adjusted by the user. This way the time can be altered to what is need for the test that is to be done.
    b. The time scale between reality and the simulation is fixed on 1 second per step. Every step the simulation takes translates into 1 second in reality.
10. The model needs to be as simple as possible while still being representative for the problem.
11. The following results need to come from the simulation:
    a. The reaction time of the swarm when handling a pollution.
        i. The time from a pollution being emerging and the first drone finding it.
        ii. The time between a drone finding a pollution and the swarm mapping the entire pollution.
    b. The reaction time of the swarm when handling driftwood. This has the same two subsubpoints as the handling of a pollution. It does have another one to add to this though:
        i. The time after the wood is found until it has been removed from the environment.
    c. The effect of the size of the swarm on its efficiency.
        i. Does a bigger swarm lead to a pollution being mapped faster and/or more accurately.
        ii. Does a bigger swarm result in driftwood being detected and removed faster.
12. Running the simulation and gaining results from it needs to done within 12 hours.