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Independent Study Proposal for Computer Science:

Virtarium

Project Name: Virtarium
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Project Goal: The goal of this project is to create a virtual environment where autonomous “creatures” live and interact.

Description: This independent study is an intermediate phase to the vision of a vivarium for inanimate (robotic) creatures in the RU atrium, the Sun.

The AirSwimmer toy is a remote controlled helium filled “blimp” in the shape of a fish. Properly balanced the fish has a neutral buoyancy in air. It has two actuators; 1) a tail capable of moving left and right (with the neutral position in the middle) and 2) an electronics casing that moves on a track on the belly of the fish. The tail propels the fish forward and can also be used to turn left or right by flapping more to one side. The position of the electronics case controls the pitch of the fish and therefore whether the fish climbs or descends as it is propelled forward using the tail.

More information about the AirSwimmer: <http://airswimmers.com/>

This project will focus on creating a software system capable of imitating the behavior of the AirSwimmers and replicating the environment in which they will live. In other words, create a crude virtual replica of the RU atrium and model the behavior of the AirSwimmers as an agent within that environment.

The focus will be on the architecture of the system as a whole and the clean separation of agents and environment as well as defining basic abstractions for individual behavior. Graphics will not play a big role in this iteration of development. A basic schooling behavior implementation should be attempted using the Boids algorithm (<http://www.red3d.com/cwr/boids/>). A major emphasis will be put on documentation and maintainability of the project.

A number of design decisions will have to be made during the course of this project such as which libraries and tools or what algorithms to use. All of these decisions should be documented in the project report along with the reasoning behind it.

Below is a list of features that the software should have:

- **Variable point of view.** The “camera” should be movable (using the mouse). The user should be able to control both location and orientation.
- **Variable number of fish.** The user should be able to configure the number of fish in the environment. This can either be implemented by specifying the number and/or location of the fish at start-up or, ideally, being able to “drop” fish into the environment at run-time.
- **Collision detection.** The individuals should not be able to pass through solid objects or each other.
- **Realistic behavior.** The individuals should behave like the AirSwimmer toys as much as possible. For example, maneuverability should be restricted to pitch, surge (forward only) and yaw. The acceleration and speed of the AirSwimmers should also be measured and matched as close as possible.
- **Agent based.** The logic of the system needs to be implemented per agent such that each individual is fully autonomous. For example, in the context of schooling behavior, each individual should only receive the needed information about its nearest neighbors. It should not have access to information that a physical individual would be unable to obtain using on-board sensors.
- **API definition.** The individuals will need to receive information about their own location as well as the location of nearest neighbors through a well defined API. The system will update individual states by calling this API and this needs to be highly configurable. For example, the system needs to make a decision about

which neighboring individual a particular individual will know about.

Below is a list of documentation requirements:

- Detailed usage documentation, explaining the use of all run-time parameters and configuration options.
- Detailed experimentation documentation, explaining all experiments done on the AirSwimmer toys, the rationale behind the experiments and the results of the measurements (acceleration, max speed, rate of turn, degree of pitch, etc.)
- Detailed API documentation for the individual state-update and the system mechanism that controls how this API is called.

The software will be released under a permissive open source license (MIT, Apache, BSD) and should preferably be implemented in Python.

Outcome: The outcome of the project will be a virtual environment with some defined obstacles. Agents will control virtual creatures in this environment which will resemble AirSwimmer fish (that is, have the same three degrees of freedom and other maneuvering restrictions). The produce of the project consists of the software itself as well as full and detailed documentation.

The student will also turn in a detailed report describing the software and rationale behind design decisions as well as discussing future work. The report should be written in english.