4 Interesting Projects I participated in as a software engineer, drone enthusiast, and artificial intelligence designer/researcher/architect.

XPrize Shell Ocean Discovery :

The challenge was for teams (our Team was Team DaVinci – comprised of 7 individuals) to develop an autonomous undersea drone which would be able to proceed into the depths and independently map out a section of seafloor then return fast high resolution scans of the sea floor in that predefined area. We did not make it to the final selection round due to costs to continue participation.

My Role(s):
I was purely software and control software, there were two electrical engineers who were working on the hardware systems as well as the power source.

1. Create the navigation system which would rely upon a low frequency (since this propagates better in water) radio fix with the surface platform. Ideally the surface platform would have 2 points located on it, with the third located on the drone itself, thereby allowing periodic triangulation. Sonar would also be employed on all 4 four surfaces of the drone (top, bottom, port, and starboard) for threat and bottom detection in shallower waters. The drone also carried a tiny antenna array which could be deployed on the end of 3000 feet of high strength fishing line.

2. Myself and another individual worked on the software for this antenna array and the onboard radio processing hardware.

3. As part of the navigation system an AI component was created which would perform course navigation based on the received triangulation points, sonar data, water pressure on the external surfaces of the drone (depth), as well the deployed tiny antenna when used.

4. Th AI ('the brain' – named after the Thunderbird's TV character (and hilariously actually fitted into the drone as a 4 inch action figure by one of the team) besides handling navigation would also map out a predefined search grid and then maintain a search pattern over that grid. The search area would be loaded into the drone by way of a hardline interface or wifi connection based on ocean seafloor maps if available.

5. Processing, compressing/encrypting, and storing the aforementioned high resolution scans.

Anti Drone Defensive Electronic Fence (Development team of 5) :

An electronic fence (a number of ground monitoring stations, the size of a show box), drone detection (main station interlinked to all ground monitoring stations), and disabling with safe retrieval solution for prisons. Here is a link to the latest news report concerning this problem (https://www.cbc.ca/news/canada/british-columbia/drug-smuggling-drones-1.6822091), we were working in this in 2016-2018 when the first news reports were causing a stir in law enforcement circles.

My Role(s):

Design the software which would:

1. Analyze collected radio frequency data across the bandwidths used or open to drone usage for command and control, looking for patterns which would indicate a drone was within detection range, this could be on either side of a prison's electronic fence. These frequencies were monitors by equally distanced RF monitoring stations encircling the area to be protected.

2. Override the commands being sent from the drone's controller and bring down the drone within the prison walls in a special area for law enforcement to retrieve it and thereby examine its

payload. This override required the design and use of a series of AI algorithms operating in tandem to both override and block flight control signals. Then once control was achieved to bring the drone safely down for law enforcement.

3. Storage of all ‘odd’ RF patterns for later analysis. Sometimes drones are used to probe electronic fences or defences of this kind (under development).

4. Software to run all of this from a dedicated computer.

Large scale Agricultural Monitoring Station with remote drone sample collection (Development Team of 6) :

A series of self-powered (batteries with wind and solar charging were what we started using) drone platforms. These were mini hangers for micro drones – they would serve as home base, data collection and transmission hub for the drones once they returned, as well as charging stations. These would be placed where desired on a farm acreage used for crops.

A central data collection and transmission station – hybrid power (self powered as before but also with a backup hardwired supply). This station would be placed centrally (i.e the best location to decrease distance to all hubs and the monitoring computer) as proposed by the main software package to create a link between the monitoring computer and the drone hubs.

Each Drone carried a small “lab” to analyze both plant and soil problems (moisture content, insect pest infestation traces, contaminants, and plant die-off), a small collection probe to retrieve soil or plant material (this the farmer or farm worker would be notified of and go out to retrieve from the hub). And a visual as well as infrared and ultraviolet camera, these images can after analysis which would be performed by the monitoring computer after transmission back and forth from ***hub*** **<->** ***central station*** **<->** ***monitoring computer*** – determine diseases and crop infestations.

My Role(s):

1. Develop/Code the command and control software for the micro drones.

2. Develop/Code the data analysis software.

3. Develop/Code the image compression and encryption software.

4. Develop/Code the transmission protocol, all AI routines, and main software for both the hubs and central station.

5. Develop/Code along with 2 others the monitoring computer's main software package.

River and Lake Water Quality Monitoring Station (Development Team of 4):

A series of self-powered (batteries with wind, wave motion, and solar charging) water drone platforms. These were mini hangers for small water drones – these platforms would serve as home base, data collection and transmission hub for the drones once they returned, as well as powering stations as these water drones were powered by wire since they only had to go out a short distance for water collection and water analysis. These would be placed along the river bank or lake shore. And up to 4 water drones could be accommodated in each one.

A central data collection and transmission station – hybrid power (self powered as before by solar and wind). This station would be placed centrally (i.e the best location to decrease distance to all hubs). This station had the ability to be connected to wifi, cell network, and more mundane transmission systems – client even wanted shortwave.

Each hub and the central station were equipped with anti-theft devices as well as anti-tamper systems.

Each Drone carried a small water collection vial as well as the ability perform rudimentary on-the-spot analysis. Data was also transmitted back to the hub for processing and transmission back the central station.

My Role(s):

1. Develop/Code the command and control software for the water drones.
2. Develop/Code the water analysis software.
3. Develop/Code the anti-tamper software.
4. Develop/Code the transmission protocol, compression/encryption software as well as all other software.
5. Develop/Code along with 1 other the monitoring computer's main software package.
6. Develop/Code the AI subsystems used to maintain the operation of the water drones, their simple navigation and return routines.
7. Develop/Code the subsystem and controlling AI for the scheduling and processing of data sent to the central station.