

# Nuytco Autonomous Sablefish Camera System

The Nuytco Autonomous Camera systems are designed to image at seawater depths of up to 1500m, using on-board lighting and power. They have been designed to operate and capture video or stills, as well as orientation and movement data, for up to 48 hours, or more if image capture frequency is less. As this system is still in the development stage, there is no operations manual per se; this document will serve as a “Quick start” guide, as well as a template to grow operational notes into something which will eventually become the manual.

**IMPORTANT: NEVER insert anything into the depth sensor, which is covered by a round shield with a small hole in it, on the side of the camera. This can damage or destroy the sensor.**

## 1. Power

Power for the unit is provided by a lithium ion battery pack. This powers the on-board electronics, data logging, lights and camera. The camera has had its own battery removed, and runs entirely off the on-board battery pack. If a battery voltage of more than 8.6v, or less than 6.5v is detected, the camera will go into shutdown mode and will have to be restarted. There is also a supercapacitor installed on the motherboard to provide power to the real-time clock when batteries are changed.

**With a fully charged battery, the camera unit has the following power capacities:**

Deep Sleep (Batteries plugged in, unit waitint to reach depth): 336 hours

Standby (Unit at depth, waiting for movement and timed input): 48 hours

Video recording with lights: 1 hour of video/light

To ensure adequate battery life, the unit should be always be deployed with a fully-charged battery.

## 2. Camera

Images are captured using a GoPro Hero HD camera, plugged directly into the system motherboard using its external bus connector. The GoPro has been set up in “One Button Mode”, meaning when it is turned on, it immediately starts taking video, or photos at timed intervals, until it is powered down. Currently it is set up to start recording a video when it is turned on, and to continue until it is powered down. If the user desires to change modes, photo/video resolution, or frame rate, then these must be configured by removing the camera from the housing and manually selecting settings using the GoPro’s LCD and button interface. In

addition, when switching from Video to Photo, the #1 selector switch on the motherboard must be switched from “On” to “Off” (See section 3, “Configuration Switches”).

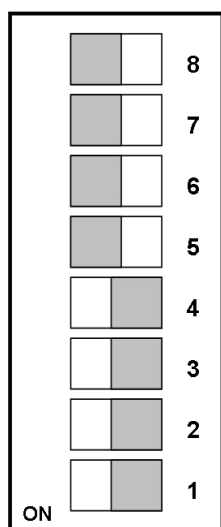
### 3. Configuration Switches

There are a total of 8 switches on the camera unit motherboards which allow users to configure imaging mode, depth at which camera activates, interval of imaging events, clip length (Video mode only), and LED lighting brightness. The following diagram shows a sample configuration with switches 1-4 in the “OFF” position and 5-8 in the “ON” position. (**NOTE: this can be confusing; in the case of Switches, 0 == closed == ON, while 1 == OPEN == OFF**)

The following settings can be used for the configuration:

Video select (Switch 1): ON = Video, OFF = Photo

Trigger Depth (Switch 2): ON = Shallow, OFF = Deep



Recording Interval (Switches 3 and 4):

ON/ON = 1 min

ON/OFF = 30

min

OFF/ON = 60 min

OFF/OFF = 120 min

Recording Duration (Switches 5 and 6):

ON/ON = 5 sec

ON/OFF = 10 sec

OFF/ON = 15 sec

OFF/OFF = 20 sec

Light Intensity (Switches 7 and 8):

ON/ON = 25%

ON/OFF = 50%

OFF/ON = 75%

OFF/OFF = 100%

#### 4. Deployment

Before deployment, the camera units should be prepped as follows:

- a) If batteries have been disconnected from the units for more than approximately 48 hours it will be necessary to reset the date and time on the Real-Time Clock using the programming tool (**See section 6, “Programming”**). A supercapacitor mounted on the motherboard should supply sufficient power for periods of less than 48 hours, but after prolonged storage, the clocks should be reset.
- b) Ensure fresh batteries are installed. As noted in section 1, voltages outside the specified range of 6.5 – 8.6V will cause system shutdown.
- c) Configure DIPswitches (See previous section, 3) to desired setting.
- d) Check condition of desiccant packet under battery strap and replace if necessary.
- e) Ensure O-ring seating surface on the inner face of the housing is free of dirt and lint, while ensuring the O-ring on the endcap is lubricated, and also free of lint or debris. With the housing camera-down on a flat surface, line up the small tapped hole in the housing endcap with the gap in the housing body, and press the endcap evenly into the housing, holding it down. While it is held down, insert and feed the Teflon rod into the retention groove all the way. A wrapping of electrical tape can then be used to secure the retention rod if desired.
- f) Ensure the three vent plugs on the endcap are securely tightened. These should never be opened or loosened, but it is advisable to check regardless. Likewise, the vent plug on the side of the unit should be checked as well.
- g) The unit is now ready for deployment. If everything is working, a green LED should be visible through one of the holes in the camera side of the housing, under the viewport. It will flash to indicate error-free operation every 16 seconds. If the unit has locked up for some reason, or is otherwise not working, this light will not blink. Within 60 seconds of reaching its specified depth setting, the camera will start imaging, at timed intervals as well as when movement thresholds are exceeded. Likewise, upon retrieval, the unit will go into sleep mode within 60 seconds of passing its depth threshold, so it should not activate on deck under normal circumstances.

## 5. Data retrieval

At recovery time, first check that the green status LED referred to in section 4 is blinking every 16 seconds. Dry the housing thoroughly. To be sure that no water enters the housing, it is sometimes helpful to turn the camera viewing port-up, then removing the retention rod from its groove before lifting the housing off the endcap. That way any water retained will drip downwards, away from the electronics. Once the endcap is removed, data can be downloaded from the camera and the onboard processor memory as follows:

- a) Attach a USB cable from the computer used for data storage to the USB header marked "CAMERA" on the motherboard. Once attached, press the button marked "Camera" alongside the DIPswitches once. In approximately 3 seconds, the camera should beep 3 times, and then show up as a removable storage device in Windows explorer. Copy the files to the location desired, bearing in mind that because the camera has no battery of its own, the time stamp on the files will be the same for all of them. File names will be ordered, however, and these can be matched up later with the data from the Microcontroller. When files are successfully copied, delete files on the camera memory, and unplug the USB cable from the motherboard.
- b) Attach a USB cable from the computer used for data storage to the USB header marked "FLASH". It should immediately be recognized as a USB mass-storage device by the PC, with one file present, "SAB\_FISH.csv". Because of the format of the file, it should be viewed in EXCEL or another more advanced text editor, as "Notepad" will cause some issues, only showing every 5 entries. This file should never be deleted from the onboard memory, so it should always be 'copied', and never 'cut' and then 'pasted' into the destination directory. Ensure the data is present in the file (If data was collected, the file will be greater than 4kb on the disk, as this is the registered size of the file with nothing more than its header). When you are satisfied that the data is present, the memory can now be cleared. This is done as follows:
  - a. Plug in the USB cable to the FLASH port, hold down the "LIGHT TEST" button, the four green indicator LEDs will illuminate, while holding this button...
  - b. Unplug the USB cable, the four green indicator LEDs will extinguish, then...
  - c. Release the "LIGHT TEST" button. The on-board memory should now be cleared, but this sometimes needs to be repeated more than once. Plug the USB cable into the "FLASH" header once more. If the file size on disk shows as 4kB, then the memory clearing operation was successful.

The unit is now ready to have a fresh battery inserted, and may be prepped for redeployment.

## 6. Programming

Though the code for the camera (Source code is named “sablefish.c”) is extensive and complex, there are certain variables which may be changed to effect different functioning of the unit in the field.

The variables which may be useful to change are as follows:

**PIVOT\_DEPTH\_0:** Shallow depth (in m) setting for activation. Set by the DP0 DIPswitch. Note that this is a FLOAT value and not an integer (i.e. 100.0 and not 100). This is found around line 331 in the code.

**PIVOT\_DEPTH\_1:** Deep depth (in m) setting for activation. Set by the DP0 DIPswitch. Note that this is a FLOAT value and not an integer (i.e. 500.0 and not 500). This is found around line 332 in the code.

**TIME:** The only way to set the time on the units is to set it within the code, recompile, then load into the processor. The section in the code where individual values for Month, Year, Day, Hour, Minute and Second are held starts at line 3461, or you can search for “set time here” to locate. We find the best thing to do is set a time for several minutes in the future, save/compile the code and then program the first camera at precisely that time. Then, program each successive camera precisely 60 seconds after the previous, and make note of the 1m incremental offsets.

**NOTE:** The supercapacitor on the motherboard has enough power to retain the clock settings for approximately 4 hours. If the batteries are left disconnected for longer than 4 hours, the clock will have to be reset in the source code, and the microcontroller reprogrammed.

**WAKEUP\_THRESHOLD:** This is the threshold for acceleration past which the camera will activate. This is found at Line 334 in the code. If the camera is being activated too easily, or not easily enough, you can try adjusting this up and down.

Additionally, you might be able to play with values for the duration of video clips, or time of intervals, as set by the DIPswitches, though I haven’t yet changed any of these. I would recommend saving a copy of the “sablefish.c” file in a safe location before any changes are made.

Once changes are made, the code can be compiled. In the top menu, go to Project-> Build all (Ctrl-F10) and the project will be compiled while you wait patiently.

Now you're ready to physically program the unit.

The PC provided for programming is set up with the "MPLab Integrated Development Environment" using a "PICKit 3" programmer. While this has been set up with the correct settings enabled, ensure the following:

- a) Under the "Programmer" tab, go to "Settings", then "Power", and ensure that "Power is off".
- b) Always ensure that the programmer is set as "PICKit 3".

Bear in mind that if the computer goes to sleep, or hibernation, that the programmer must be disconnected and then reconnected again.

The cable between the Programmer and the camera is custom, and care must be taken to ensure it is properly oriented. On the programmer end of the cable, the red wire is pin number two, so it must be closer to the "Arrow/Triangle" mark on the programmer. Likewise, on the connections on the camera motherboard, it must be oriented so that the red wire (pin 2) is towards the dot denoting pin 1. When this end is inserted into the motherboard, status LEDs will flash on the board, and a window within MPLab will indicate "Target Detected" the "Program" icons on the right of the drop-down menus will go from greyed-out to active, and you may click on the first, which will program the microprocessor. It is best to hold the cable in the holes during the 5 or so seconds it can take to complete the programming. After MPLab indicates the programming is complete, you may remove the cable; the unit is now programmed.

Occasionally, the unit may enter a 'locked-up' state, where the batteries are sufficiently charged but the green status LED is not blinking every 16 seconds. In this case, the unit may be unlocked by connecting the programming cable to the header on the motherboard, which will cause it to reset, as it would if you were programming it. Aside from having the programmer powered and MPLAB running, no other action is required when the connection is made. The LEDs on the motherboard will blink as they would normally, and the microcontroller should then be successfully reset.