Title
Solar-Powered GPS Trackers for Small Scale Fisheries Monitoring Set-Up Instructions

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FISHERIES NET

Solar-powered GPS trackers for Small Scale Fisheries monitoring

Set-up Instructions

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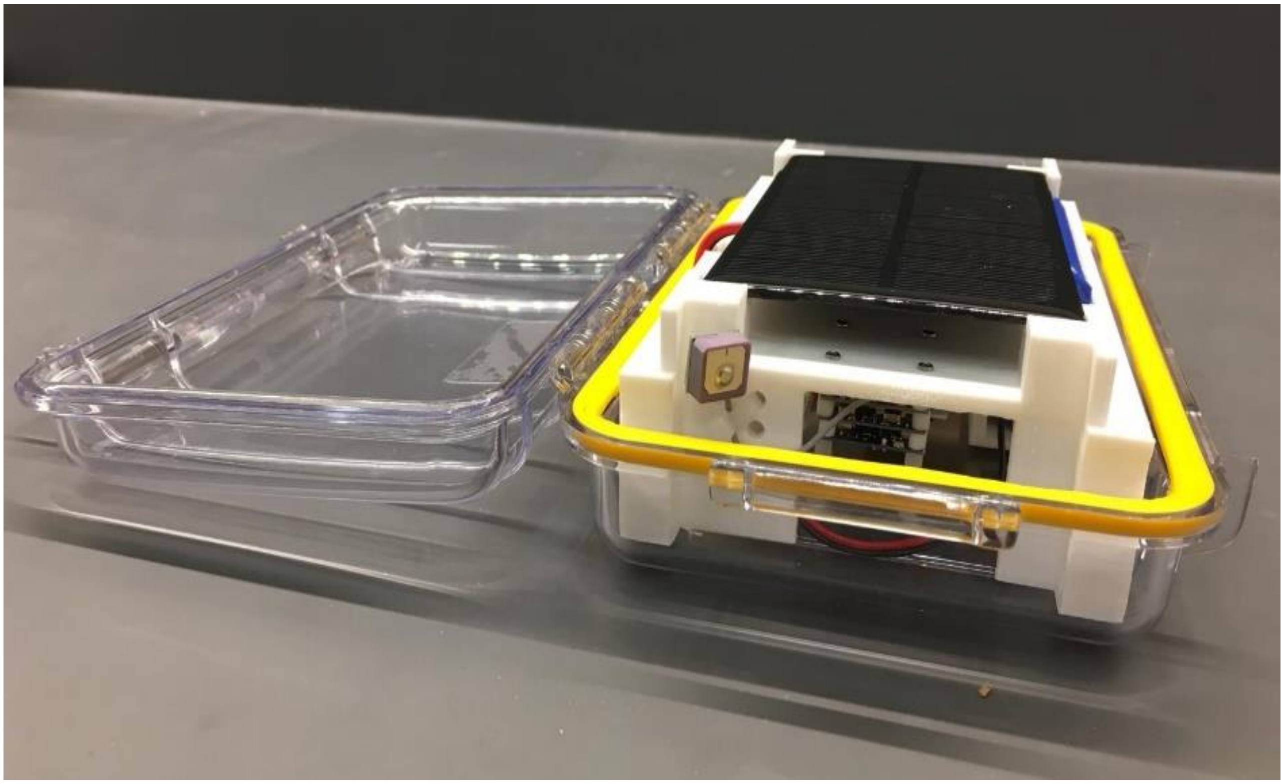
Gulf of California Marine Program. 2018. FisheriesNET: Solar-powered GPS trackers for Small Scale Fisheries monitoring. Set-up instructions.

Introduction

Since 2009 the Gulf of California Marine Program (GCMP) has adopted the use of portable GPS trackers and in-field technicians to overcome logistical challenges and collect fisheries data. These efforts have provided useful information on Small Scale Fisheries (SSF) fishing practices in coastal communities along the Gulf of California and Mexican Pacific. The resulting data has led to publications by Erisman et al. (2012, 2015) on the seasonal fishing practices and landings of a variety of species, including the gulf corvina (*Cynoscion othonopterus*) fishery that accounts for the most biomass harvested in the Upper Gulf of California. The information gathered using GPS devices also allowed GCMP scientists to publish an analysis piece regarding the impact single-species conservation efforts can have on fisheries and the communities that depend on them (Aburto-Oropeza et al., 2017). This methodology has also allowed researchers from the Centro para la Biodiversidad Marina y la Conservación to study the artisanal fisheries in Bahía Magdalena, which they have described in detail (Cota-Nieto et al., 2017).

FisheriesNET team members have designed and produced a compact GPS tracker model equipped with rechargeable batteries and a solar panel. Information recorded by the trackers includes automatically incremented offshore trip number, vessel speed, and distance from port (a user defined position), mitigating post-collection processing time. The autonomous units are installed on vessels of SSF to effectively monitor temporal and spatial patterns of fishing effort for individual boats, fisheries, and communities over long periods without the need of direct short-term maintenance.

Our standalone software allows users to visualize large datasets in google maps, generate time series of vessel speed and distance traveled, filter data by trips number and vessel speed, and identify actual fishing locations using statistical and visual tools. Further development of software for FisheriesNET will permit remote access to stored data through a direct Internet connection to secure servers, allowing for real-time monitoring of fishery data. The combination of standalone and web-based software will increase the availability of information to a network of parties interested in SSF and provide access to an information storage, sharing, and analytical platform.



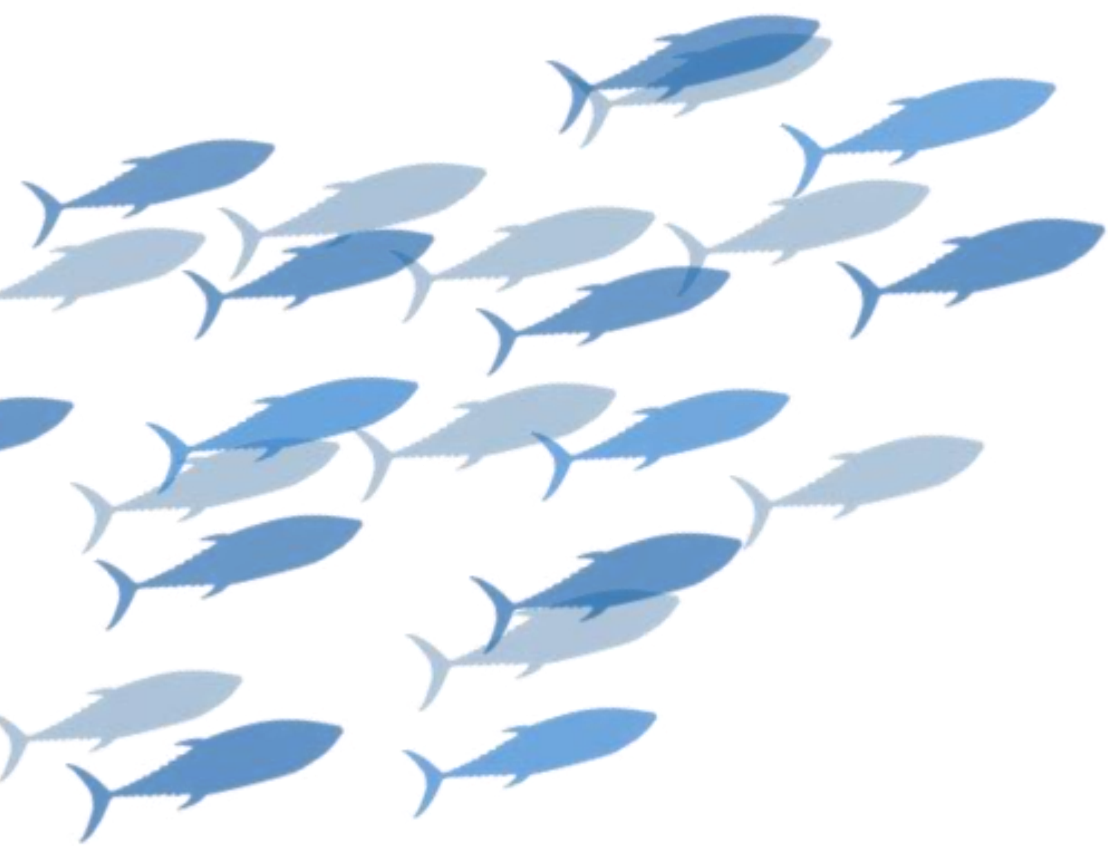
Solar GPS tracker designed by the Gulf of California Marine Program.

FisheriesNET objectives

(1) Develop a cost-effective long-term solar powered GPS tracker and catch monitoring system.

(2) Design and launch a standalone software and publicly available web-based interface to visualize and analyze GPS and catch data.

(3) Promote the use of this methodology to NGOs, scientists, fishermen, and government agencies to increase fisheries data collection.



Solar Tracker - Hardware

The hardware side of the FisheriesNET project, is made of a series of Arduino-based devices to know the locations of SSF boats during their fishing trips. The GPS devices use a web-based application with a TinyCircuits TinyZero processor, based on Atmel SAMD, equivalent to an Arduino Zero processor.

The GPS device is built with TinyCircuits shields and a 32-bit processor. There are three Shields, described below:

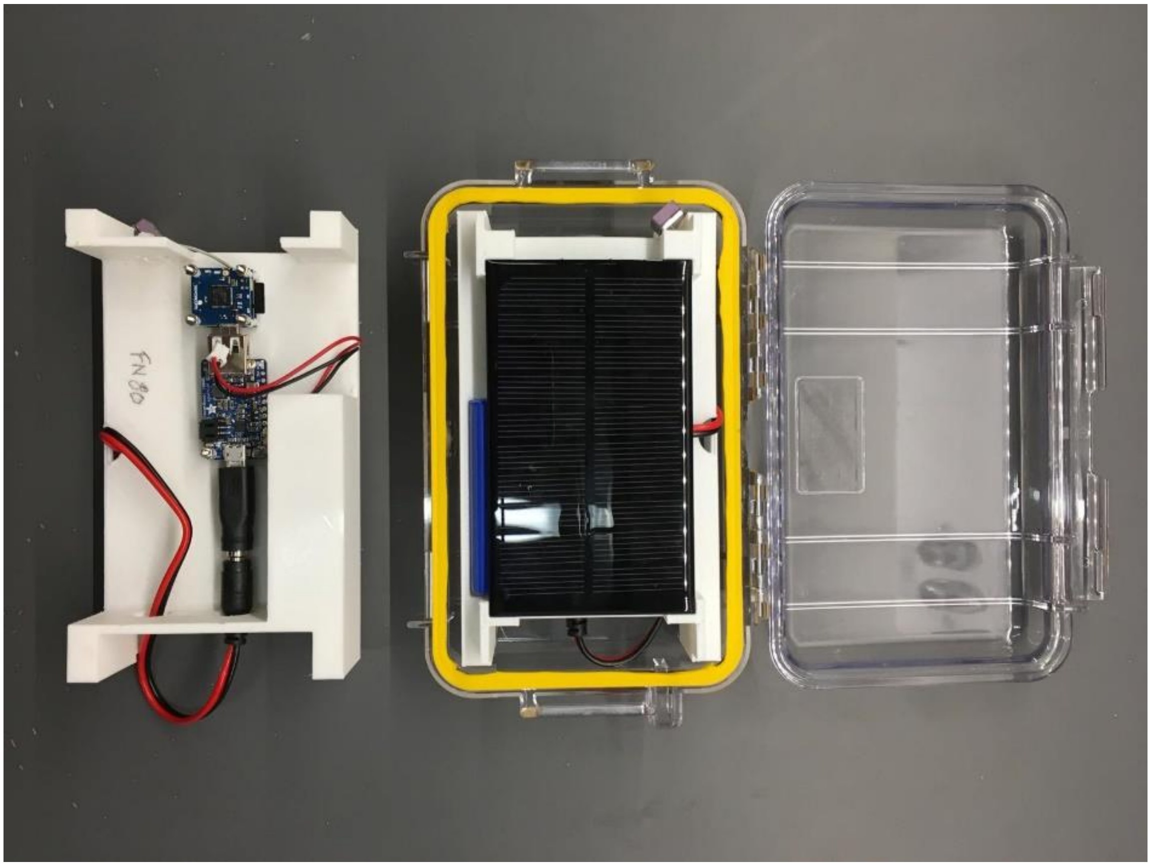
- GPS shield: Allows us to know the device's location and can be programmed to get tracking position every second or wider intervals of time.
-
- SD shield: Helps store tracking position in a microSD card.
-
- Radio shield: Allows to send information stored in the microSD card to a gateway computer. Distance range is around 500 meters in open view.

The Gateway device is built using a TinyCircuits shield and a 32-bit processor. This device only needs one Radio shield and is responsible for acquiring data from GPS devices, to later send it to a Gateway computer that will backup info and send it to a server.

The Gateway computer can be a Raspberry Pi 2, Raspberry Pi 3, Raspberry Pi Zero W. This computer should run Raspbian and requires an internet connection to send the data collected through the Gateway device to a server.
To program GPS devices and Gateway devices please review section "**Arduino IDE setup**" where information on how to configure a

MacOS X computer to be used to program all GPS devices can be found. Information regarding device programming can be found in section "**Devices setup**".

To configure Gateway computers review section "**Gateway Computer**". Note that the configured computer will be where all work and data will be stored. Expected computer models are Raspberry Pi mini computers.

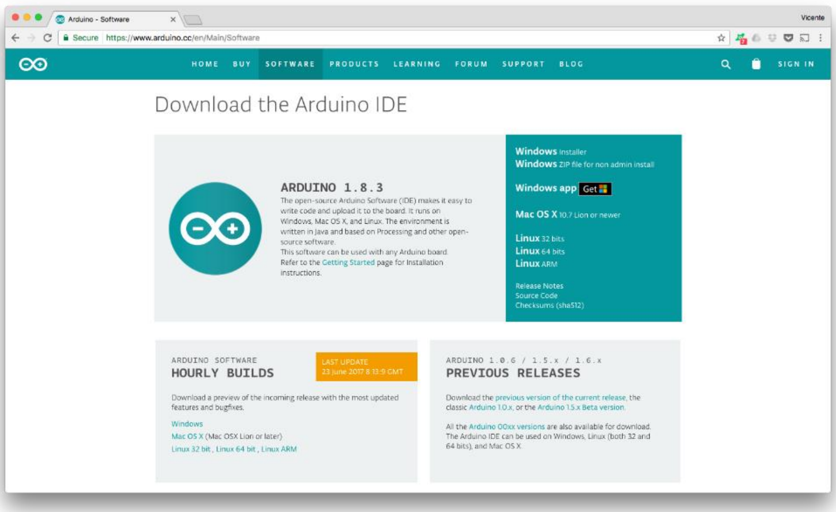


Solar GPS tracker designed by the Gulf of California Marine Program showing its internal components and the solar panel used to charge the batteries. The GPS tracker is built inside a water-proof container to minimize damage and allow easy access for maintenance and/or repairs.

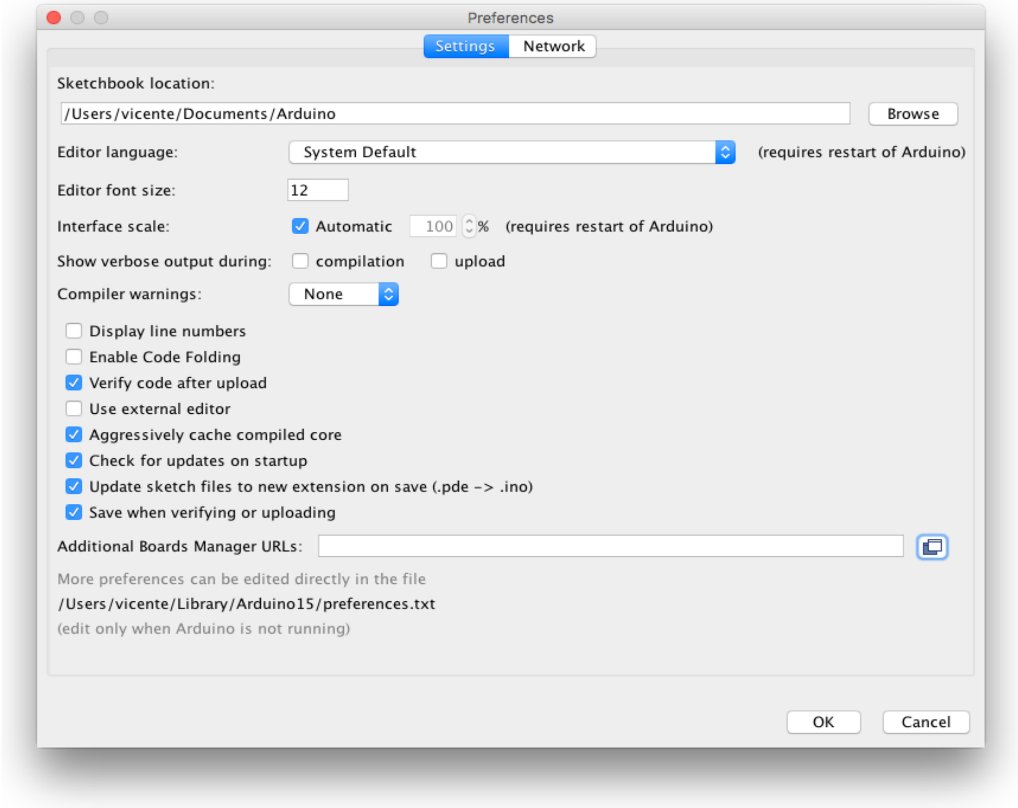
The solar GPS tracker designed by the Gulf of California Marine Program is installed on the SSF boat to guarantee it records the boat's position and movement during the fishing trip. Data is later extracted from the memory card on the tracker.

Arduino IDE setup

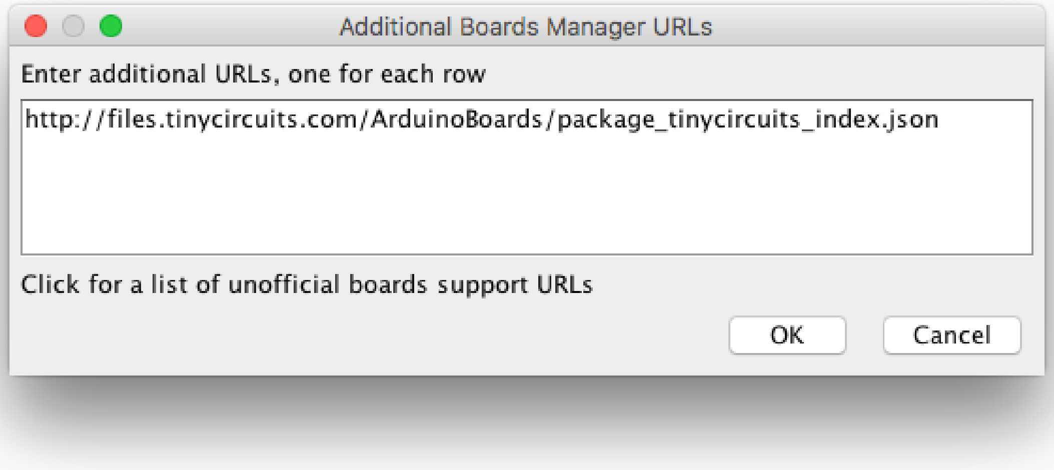
1. Download and install Arduino IDE 1.8.3 from www.arduino.cc.



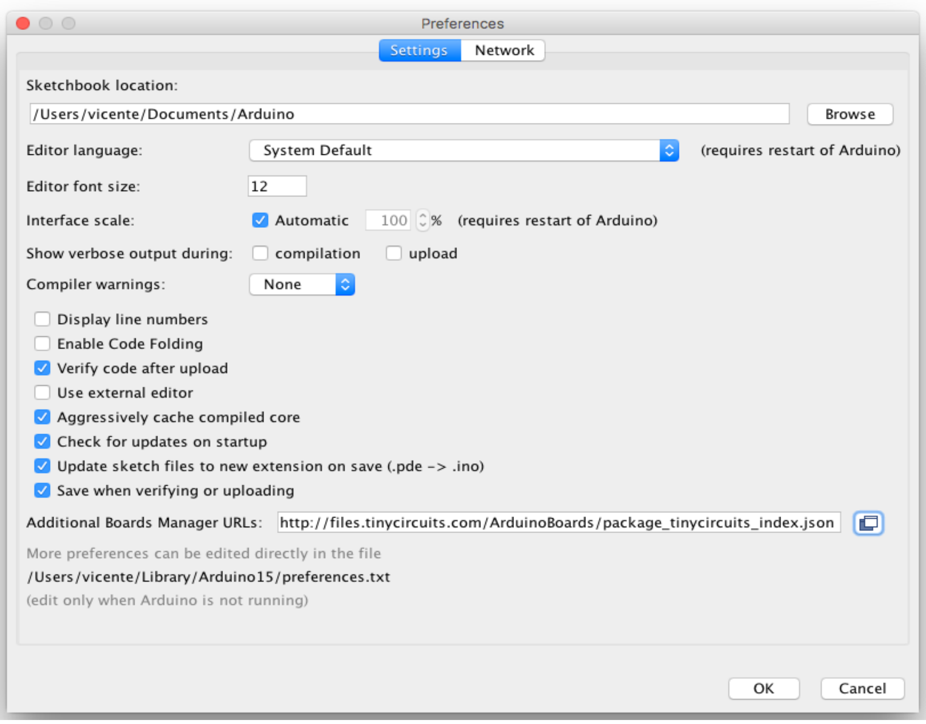
2. You must add support for TinyCircuits processor boards. Open Arduino IDE and go to "Arduino/Preferences…" menu:



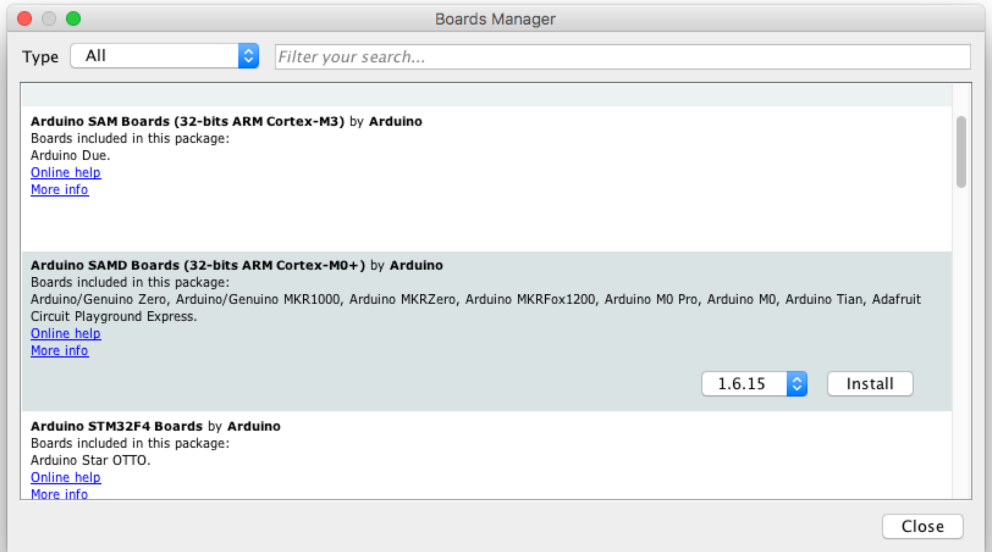
3. Click last little button in the row where label "Additional Boards Manager URLs:" is to open next window and enter "*http://files.tinycircuits.com/ArduinoBoards/package_tinycircuits_index.json*".



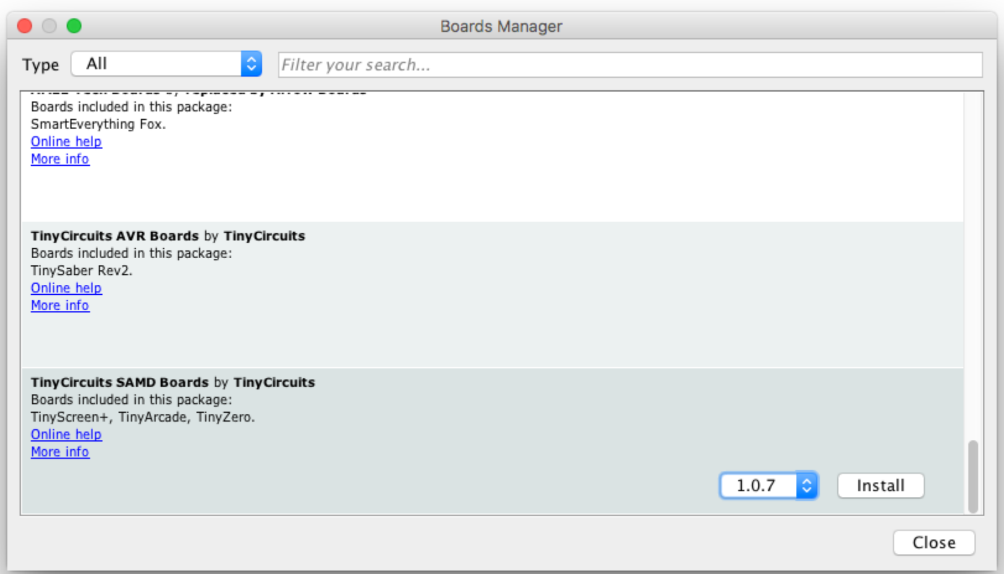
4. Click “OK” button to close window. You should see something like the picture below; press “OK” button to continue.



5. Open the "Tools/Board:/Boards Manager…" menu in the window that opens and locate the row containing "Arduino SAMD Boards (32-bits ARM Cortex-M0+)"; click on it and click the "Install" button.



6. Now locate the row containing "TinyCircuits SAMD Boards" and click on it; click "Install" and then "Close".



7. Next, open a terminal and enter the following commands:

cd

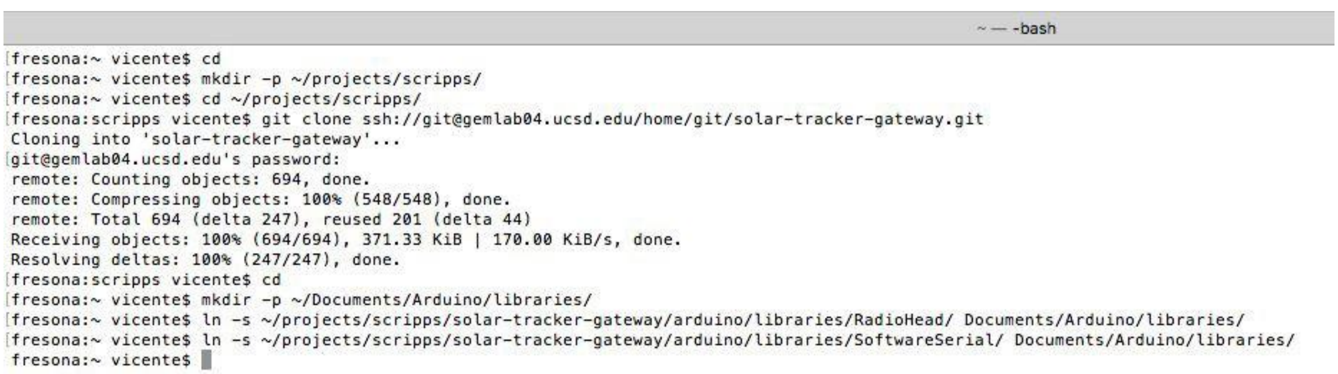
mkdirp~/projects/scripps/

cd~/projects/scripps/

git clone ssh://git@gemlab04.ucsd.edu/home/git/solar-tracker-gateway.git cd

mkdir -p ~/Documents/Arduino/libraries/ln -s ~/projects/scripps/solar-tracker-gateway/arduino/libraries/RadioHead/
documents/Arduino/libraries/

ln -s ~/projects/scripps/solar-tracker-gateway/arduino/libraries/SoftwareSerial/ Documents/Arduino/libraries/

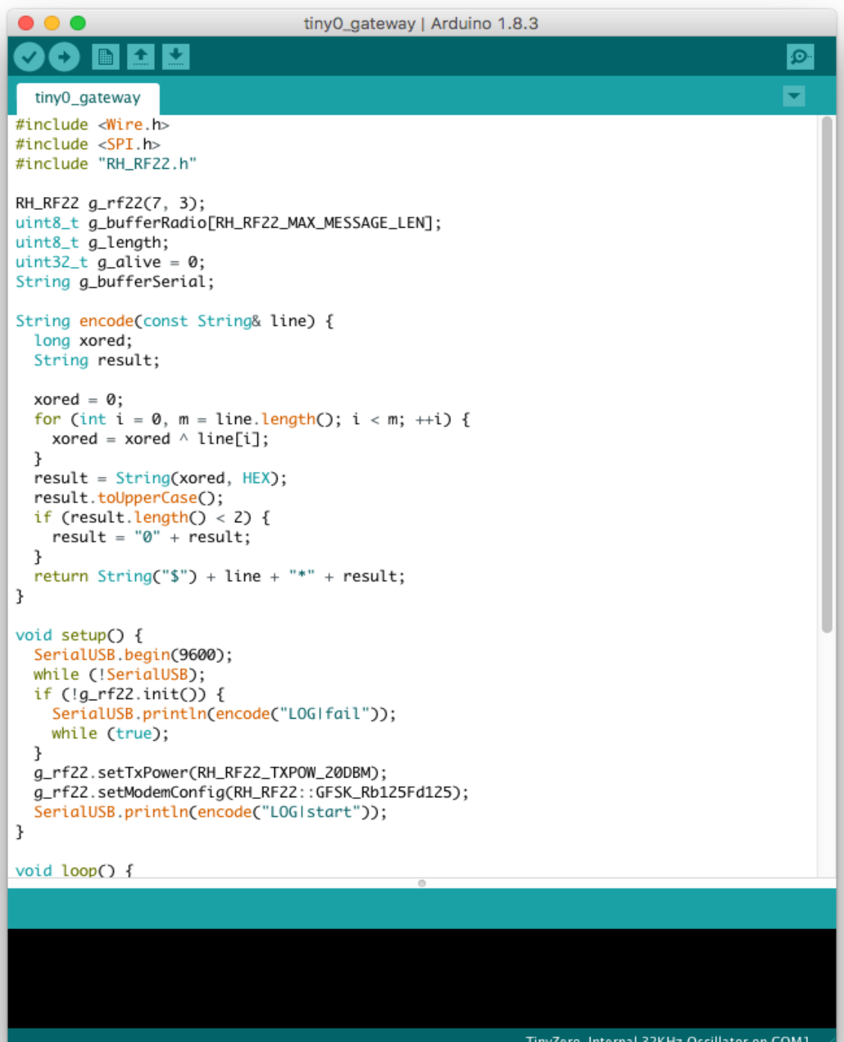


Devices set-up

A. Gateway device set-up

1. Open Arduino IDE and load the following sketch:
~/projects/scripps/solar-tracker-gateway/arduino/sketches/tiny0_gateway/tiny0_gateway.ino

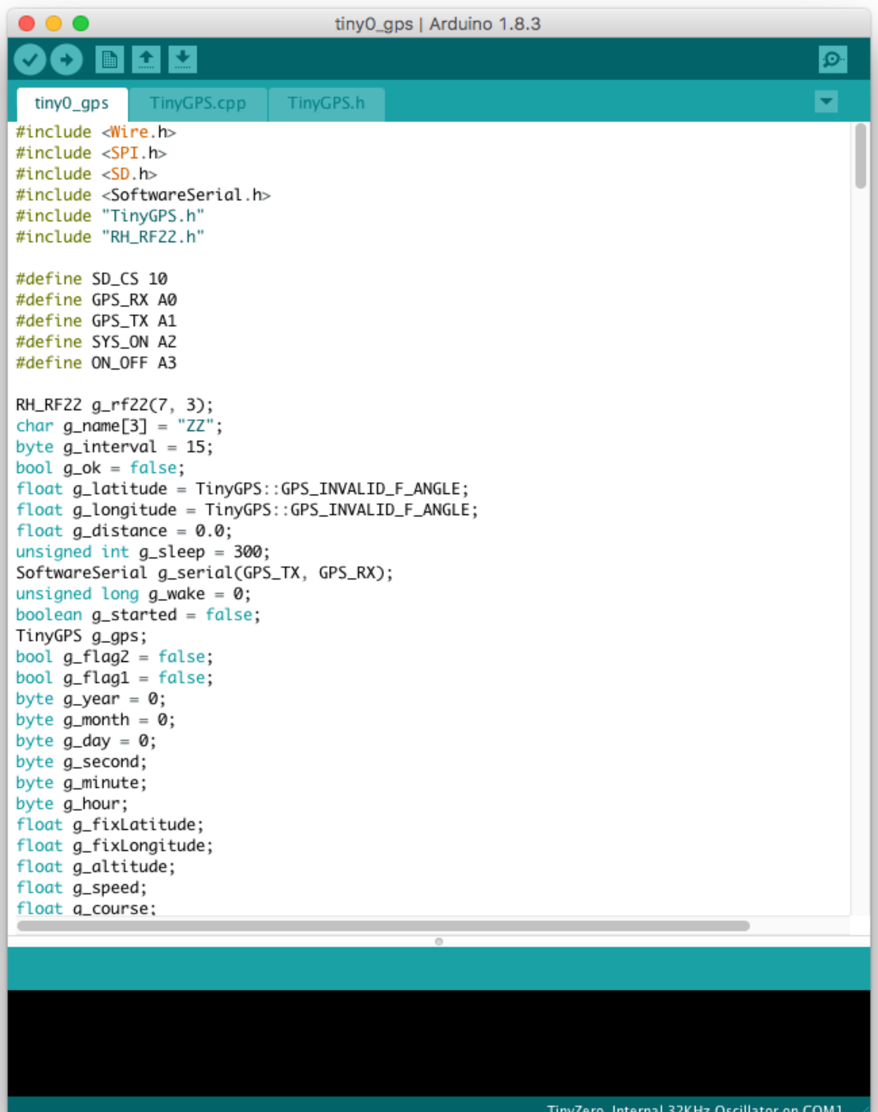
2. Choose "TinyZero" in the "Tools/Board" menu and then "Internal 32KHz Oscillator" in the "Tools/Build Option" menu. Next, upload the sketch.



B. GPS device set-up

1. Open Arduino IDE and load the following sketch:
~/projects/scripps/solar-tracker-gateway/arduino/sketches/tiny0_gps/tiny0_gps.ino

2. Choose “TinyZero” in the “Tools/Board” menu and then “Internal 32KHz Oscillator” in the “Tools/Build Option” menu. Next, upload thesketch.



The GPS devices need a configuration file inside their micro SD card named "settings.ini". This file contains the following information:

a) Name: two characters used to identify a specific device; both characters and numbers can be used.

b) Interval: number of seconds between tracking position recordings.

c) Latitude: coordinates where Gateway computer is and where information is sent once GPS device detects it is nearby.

d) Longitude: coordinates where Gateway computer is and where information is sent once GPS device detects it is nearby.

e) Distance: distance, in meters, to Gateway computer so transfer of data begins.

f) Sleep: once GPS is near a Gateway computer, the device can go into sleep mode to save energy. This variable specifies the time, in seconds, the device will be in sleep mode.

An example of how the content of a *settings.ini* file looks like can be seen bellow:

Name = 00
Interval = 15
Latitude = 32.715736
Longitude = -117.161087
Distance = 50
Sleep = 60

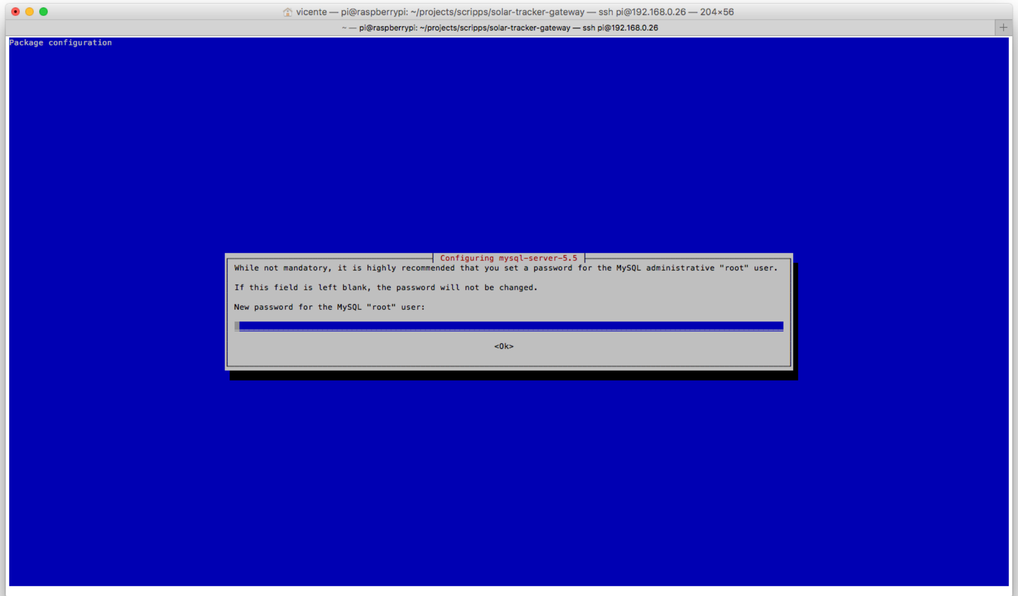
In the example above, a GPS device will be identified as "00" and its position will be taken every 15 seconds. If distance to a Gateway computer is 32.715736, -117.161087 (lat / long) and less than 50 meters, then the GPS device will begin to send data. The GPS will go into sleep mode and wake up and check its position every 60 seconds. If it hasn't been moved, then it will continue on sleep mode, otherwise it will begin to record data every 15 seconds.

Gateway Computer set-up

1. Open a terminal to enter the following commands:

cd
sudo timedatectl set-timezone
America/Tijuana mkdir -p
projects/scripps
cd projects/scripps/
git clone ssh://~~git@gemlab04.ucsd.edu/home/git/solar-~~
tracker-gateway.git cd solar-tracker-gateway
echo prod > MODE

2. Enter "*make install*" command and when it prompts you to enter the *mysql* server password, enter "*root*".



3. The following commands are needed to create a database:

cd
database/prod/
make install
make build

4. Add a service to listen to a Gateway device for incoming data and another service to upload received data to a web server:

sudo crontab -e

```
cat tables.sql | mysql -u root -proot solar_db
[pi@raspberrypi:~/projects/scripps/solar-tracker-gateway/database/prod $ sudo crontab -e
no crontab for root - using an empty one

Select an editor.  To change later, run 'select-editor'.
  1. /bin/ed
  2. /bin/nano        <---- easiest
  3. /usr/bin/vim.tiny

Choose 1-3 [2]:
```

5. Press *Enter* to choose default (nano editor) or choose the one you prefer; add the following two commands in the editor box that opens:

@reboot /opt/solar-tracker/solar-tracker-gateway.py start
@reboot /opt/solar-tracker/solar-tracker-uploader.py

6. Press Ctrl + O and Enter, then Ctrl + X

7. After rebooting (command: *sudo reboot*) you can connect a Gateway device.

References

Aburto-Oropeza, O., López-Sagástegui, C., Moreno-Báez, M., Mascareñas-Osorio, I., Jiménez-Esquivel, V., Johnson, A. F. and Erisman, B. (2018), Endangered Species, Ecosystem Integrity, and Human Livelihoods. CONSERVATION LETTERS, 11: e12358. doi:10.1111/conl.12358

Cota-Nieto, J.J., Jiménez-Esquivel, V., Mendez-Espinoza, D., Mascareñas-Osorio, I., Aburto-Oropeza, O. y López-Sagastegui, C. 2017. Programa de innovación científica como herramienta para el fortalecimiento de la actividad pesquera sostenible en Bahía Magdalena, B.C.S. Reporte FONSEC SEMARNAT-CONACYT. No. 263050. Centro para la Biodiversidad Marina y la Conservación A.C.- Gulf of California Marine Program. 20 pp.

Erisman, B., Aburto-Oropeza, O., Gonzalez-Abraham, C., Mascareñas-Osorio, I., Moreno-Báez, M. & Hastings, P.A. (2012). Spatio-temporal dynamics of a fish spawning aggregation and its fishery in the Gulf of California. *Scientific Reports* volume 2, Article number: 284. doi:10.1038/srep00284

Erisman, B., Mascareñas-Osorio, I., López-Sagástegui, C., Moreno-Báez, M., Jiménez-Esquivel, V., Aburto-Oropeza, O., A comparison of fishing activities between two coastal communities within a biosphere reserve in the Upper Gulf of California. (2015). *Fisheries Research*. Volume 164, April 2015, Pages 254-265.

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Marine Program