

Introduction to Raspberry Pi in Environmental Science

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1 Introduction

1.1 What is Raspberry Pi?

The Raspberry Pi is an tiny computer, that includes a tiny processor, a bit of memory, a slot for an SD card, and some input/output jacks, e.g. HDMI, USB, headphone, camera, and pin header for various sensors.

1.2 Why use Raspberry Pi?

The Pi has a lot of functionality and flexibility for develop monitoring of environmental parameters.

1.3 Uses in Environmental Science

1.3.1 Weather and Climate Change

1.3.2 Air Pollution Monitoring

1.3.3 Soil Water Monitoring and Irrigation Control

The automatation of irrigation is ubiquitous, however, in many cases systems don't have feedbacks that control the system. The first step relies on sensors to monitor soil moisture and temperature and then use plant growth models to control an irrigation system.

Here are some resources that describe how these can be done:

- [Soil Soil Moisture Sensors and Loggers](#)

1.3.4 Conservation

Conservation biologists use a wide range of instruments to track and monitor wildlife (camera traps, active (radio) and passive (RIF) transmitters). In addition the use of cameras are used to evaluate plant health and diversity (spectral analysis).

1.4 Resources

1.5 Raspberry Pi

The Raspberry was created to help non-technical youth to learn computer and robotics. The Raspberry Pi was an unexpected success and now the Pi is one of the most important minaturized computers for a wide range of projects.

The RaspberryPi.org has tutorials, software updates, and example projects.

1.5.1 Unpacking the Raspberry Pi

When you recieve your Pi, plan on spending about 1-2 hours setting it up which include the following steps:

1. Unpack Kit Contents
2. Put Pi in case and add heat sinks
3. Connect to keyboard, mouse and monitor. Make sure the HDMI plug is in the correct mini-HDMI socket and the monitor is configured to get a signal from the port being used.
4. Insert pre-loaded SD card
5. Plug-in Pi, you'll see a rainbow screen for a minute and then a installation menu.
6. Install the Rasbian operating system only. This will take 10 minutes. Read the little windows so you know some of the resources associated with the operating system. The installations stalls at the end, where it says 100%. Be patient, it will finish on it's own and reboot.
7. Once the Rasbian OS starts, you'll see four raspberries at the top and then you'd get some prompts to set up the OS.
8. I suggest you keep the password as default for now, select the langauge, keyboard type, and time zone.
9. Next you'll need to get connected to the internet. Select your modem and enter password to connect.
10. Then you'll get a prompt to check for updates. Yes, there will be updates. This will take another 10 minutes. About 1/2 way the screen goes completely blank. This is because, by default, the Pi goes into screen saver mode without mouse or keyboard inputs. Move the mouse or type something and the screen should wake up.
11. Be sure to shut down your Raspberry Pi before unplugging it; do this with the code "sudo shutdown -h now". Note that once you've shut it down, you will need to unplug it and plug it back in to get successful readings or use remote access.

1.5.2 Video Tutorials

One good way to start is to watch the following video series that introduced the Raspberry Pi.

1.5.3 Screensaver

1. To keep the screen from going blank after ten minutes of inaction, use `"$sudo apt-get install xscreensaver"`. If this doesn't work, make sure your `sudo` is up to date with `"$sudo apt-get update"`.
2. Once you've done this, go to the Raspberry icon in the upper-left corner and select "preferences" from the drop down menu. Under "preferences" there is an option for "screensaver".
3. Once in screensaver, under the "Mode" dropdown you can select "disable screensaver".
4. Now your screen should stay active even if you aren't actively using it.
5. More information/different methods are available at:

1.6 Remote Access

It doesn't take too long (10 minutes once you get the hang of it) to be able to work remotely on your microprocessor via a tablet or laptop. More information at

1. Begin by making sure all of your packages are up-to-date (even if you updated while setting up your OS, you will still need to do this). Do this with the code `"$sudo apt-get update"` and then `"$sudo apt-get upgrade"`. This will take several minutes.
2. Enable the SSH server by typing `"$ifconfig"` into the console. This will lead you to a screen with several options; select option five, "interfacing options," and then select option two for "SSH." Enable the server, and then exit this screen.
3. Note that Raspberry Pi updated in November 2016 so that SSH is disabled automatically. You will need to turn it on in order to progress.
4. Type `"$ifconfig"` into your console to find your Raspberry Pi's inet address under the "wlan" subcategory. This should be a string of numbers that looks something like `"192.168.XXX.X.XXX."` You will need this to access your Raspberry Pi remotely.

1.6.1 Option 1: Access to the Raspberry Pi GUI

1. Install the package necessary to remotely access your screen: "`$sudo apt-get install xrdp`".
2. Connecting to Mac or Linux OS: open the terminal and add "`ssh pi(at)(inet)`".
3. Connecting to Windows OS: this is a bit more involved; you will need to download an SSH client.
4. The Microsoft "Remote Desktop Connection" app is available for free, and is pretty intuitive to use. Download this, and follow the instructions to set it up.
5. Once it is installed, all you will need to do is enter the inet address you found above into the text box
6. A page will open for you to add your username and password (which at this point should still be "pi" and "raspberrypi"). Then your console will open.
7. If it won't connect: make sure your microprocessor and the computer you are attempting to access it from are on the same wifi;
8. make sure your microprocessor is connected and hasn't gone to sleep;
9. make sure you've properly enabled all of the packages (I had to try to run xrdp twice to get it to work the first time).

1.6.2 Access to Raspberry Pi via SSH

Note that for this option, your Raspberry Pi processor only needs to be connected to a power source (no external display is necessary). However, it is the raw code - not exactly a visually-friendly experience, but much more convenient if you can only hook up your processor to, say, a TV.

1. For Windows: (if you have Mac OS or Linux, skip this step!) First, make sure you have OpenSSH Client installed. Go to settings, Apps, Apps and Features, Optional Features, Add a Feature, and then add the client.
2. Open your Powershell (which acts sort of like an app, you can access it in the search bar) as an administrator, and then type "`Ssh [username]@[identifier]`" (the IP address that you found above).
3. Once you press enter, it will ask if you trust it (say yes, you will only need to do this once).
4. Next it will ask you for your password. Note: As you type, no characters will appear on the terminal (for privacy). This is ok, once you have typed your password just press enter.

5. The terminal should now look like the Raspberry Pi terminal that you get via HDMI, with "pi@raspberrypi: \$" as the beginning of your lines. Hooray!

1.6.3 Troubleshooting Remote Access

1. Your microprocessor needs to be connected to a powersource in order to remotely access it.
2. Both the GUI and main terminal options can be rather glitchy; if the program quits, wait a moment and then log back in. It may not work on the first try, but do it again and it should connect.
3. Make sure that your computer is connected to Wifi, and that it is connected to the same Wifi network your microprocessor is on.

1.7 Projects General-purpose input-output Examples

1.7.1 Weather and Climate

1.7.2 Air Quality

1.7.3 Sensors

Particulate Matter

NOx

O3

CO

Temperature and Humidity

1.7.4 Software

- Python Script

1.7.5 Soil Moisture

Tutorials in using a Pi to monitor soil moisture:

- [Simple and Inexpensive Method](#)
- [Raspberry 3 and Capacitance Sensors – More Accurate, limited corrosion](#)
- [moisture-sensor-dfrobot?](#)

1.7.6 Wildlife

Poacher Cam v7, Chris Kline, panthera.org