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Creating Mobile Sensor Units – With Application to Soil-Moisture Sensing

(A Technical Note)

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Abstract

Work to date has focused on establishing the ability to communicate via LoRa wireless technology and on the process of sensing, sending, receiving, and processing soil-moisture data. Power was supplied to two transceiver units by USB cables connected either to a computer or a charging unit. Conditions have been inside a building. This technical note concerns an early effort to power the sensing unit by battery in outdoor conditions. This is necessary for practical application of the technology under all-weather conditions. This note speaks to the beginning of that transition.

Background

There are many types of batteries one could use in an application like this. A summary of rechargeable batter types is given in https://batteryuniversity.com/article/bu-107-comparison-table-of-secondary-batteries. I recommend rechargeable as a prelude to solar recharge to extend battery life. But, that is not necessary at this early stage. Non-rechargeable grocery-store batteries are ok for quick experiments but one should not expect long life from them in this type of application. There are any number of battery packs one can purchase for non-rechargeable batteries. An example is https://amzn.to/3pQV7wD. Of course, there are rechargeable versions of common batteries. So, such battery packs have a dual use. Another option is a 9v battery connector, such as https://amzn.to/2ZyVGQK. Whichever battery you choose, be sure to take Uno's voltage limits into account (https://store-usa.arduino.cc/products/arduino-uno-rev3). These apply to voltage entering through the voltage regulator. There is also a 5vdc max-input pin that bypasses the regulator. Another presentation on this topic is here: http://cactus.io/platform/arduino/arduino-uno. Be sure to follow the published guidance or you will burn out your Uno.

Another side of the coin is all-weather operation. This concerns temperature, moisture, and vibration. There is also the matter of physical security. (Yes, ne'er-do-wells steal and destroy.) Weather-proofing is interesting in that one must protect against temperature and moisture. Conditions for electronics and sensors must be within their tolerances. "Moisture" must extend to waterproofing, in the event of flooding. (My installation is at ground-level.) If insertion in a water tank is called for, one cannot just go with "waterproof". One has to consider pressure due to depth. "Waterproof to what depth for the fluid in question" is the question to answer. "Rainproof" is sufficient in most non-flooded conditions but the vibration of heavy wind, snow, rain, and hail must be considered. These physical conditions cannot be ignored. It becomes more expensive to implement as harsher conditions arise from which equipment must be protected.

What has been done

Took a VERY simple approach this first time out. Used a common 9v battery to provide power to the Uno (https://amzn.to/2ZyVGQK). Used one of my wife's cake-bowls from Tupperware for "weatherproofing", after promising not to drill any holes in the bowl, or otherwise ruin it. (You guys be wary of messing with your wife's cooking equipment. 😊) Then the whole thing was put out in a light rain, behind a storage shed and at maximum distance from my inside basestation. Everything worked well using the software developed in the posted code modules. No moisture was found inside the bowl after several hours. The software continued to send data from the soil-moisture sensor that was inserted half-way into a cup of water.

What Next?

Purchased a 2000maH Lithium-Ion Battery. (Notice the connector on the battery.) These batteries come uncharged. Used a Mini Lipo Charger w/Mini-B USB Jack to do the initial charge. This took about a 1.5 days given its default settings. Connecting the battery to the charger required a USB Cable - A/MiniB.

Battery and sensor have to be connected to the Uno. Need to work a way out to do this. As we go forward, some soldering is likely to be required. Perhaps a breadboard will do for proof-of-concept.

Another point is when to recharge the battery. The sensing unit should report when it's battery is getting low. Also, the unit should go into deep sleep between sense/send cycles. Going to have to modify existing sensing-unit software so that it has that capability. Receiver software has to be modified to differentiate between messages containing sensor data and messages containing battery voltage, for each sensor. This should not be difficult. One could always rely on sensor messages as a heartbeat. When the heartbeat is no longer received from a given sensor unit, the basestation could report an issue with that unit. Still, it would be best to have advanced warning that contained diagnostics.

Finally, it is important to use a container designed for all-weather conditions. And, a capacitive soil-moisture sensor designed for outside use should be used instead of the present resistive sensor designed for indoor use. A means for having the sensor outside the container and inserted into the ground is needed, without ruining the all-weather nature of the container.